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# Orbital Anomalies in Goddard Spacecraft for Calendar Year 1994

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## Abstract

During 1994, GSFC had 27 active orbiting satellites and one Shuttle-launched and -retrieved “free flyer.” There were 310 reported anomalies among 21 satellites and one GSFC instrument (TOMS). GOES-8 accounted for 66 anomalies and SAMPEX reported 155 “anomalies.” Of the 155 anomalies reported for all but SAMPEX, only 4 affected the spacecraft missions “substantially” or greater; that is, presented a loss of more than 33% of the total missions. The most frequent subsystem anomalies were Instrument/

Payload (44), Timing Command and Control (40) and Attitude Control Systems (33). Of the non-SAMPEX anomalies, 29% had no effect on the missions and 28% caused subsystem or instrument degradation and for another 28% no anomaly effect on the mission could be determined. Fifty three percent of non-SAMPEX anomalies could not be classified according to “type;” the other most common types were “systematic” (35), “random” (19) and “normal or expected operation” (15). Forty percent of the anomalies were not classified according to failure category; the remaining most frequent occurrences were “design problems” (50) and “other, known problems” (35). SAMPEX anomalies were covered in a separate section of the report because that project did not report and classify its anomalies in a format consistent with the other projects.

## Background

The performance of Goddard-managed spacecraft has been recorded since the earliest days of the Center. However, the available data generally was collected and analyzed only within each project or program. More detailed data encompassing all of Goddard’s spacecraft began to be collected and analyzed about twenty five years ago. In 1983, the first detailed report containing performance data over all spacecraft was issued as a contractor report, Analysis of Spacecraft On-Orbit Anomalies and Lifetimes, PRC R-3579, February 10, 1983; this report covered the period from 1978 to mid-1983 and contained data covering Jet Propulsion Laboratory (JPL) and Goddard Space Flight Center (GSFC) spacecraft. The next report, Orbital Anomalies of Goddard Spacecraft 1982-1983, included only GSFC spacecraft. Subsequent annual (GSFC) reports have been issued since 1984 by the Office of Flight Assurance.

## Introduction

This report summarizes and updates the annual on-orbit performance between January 1 and December 31, 1994, for spacecraft built by or managed by the Goddard Space Flight Center. It is one of a series of similar reports which collectively present a published record of spacecraft performance. The report summarizes overall performance of GSFC spacecraft and catalogues anomalous performance (reported as “anomalies”) for each spacecraft. To the extent possible, each anomaly is classified according to the subsystem in which it occurred, the time of its occurrence, its effect on the spacecraft’s mission (“criticality”) and the failure causes and corrective actions, if known.

The initial pages list active spacecraft covered by the report and summarize spacecraft activity during the year. Next, spacecraft operations are briefly described for each craft in “Spacecraft Operation Summaries.” Anomaly data for 1994 are presented and classified in “Detailed Anomaly Data” and data tables are presented to illustrate anomaly distributions among several classifications. SAMPEX anomaly data are reported in a separate section because of their large number and their reporting system was not

consistent with those for the other spacecraft. Logs of 1994 anomalies are presented in Appendices II and III and GSFC's "Spacecraft Lifetime Data" is updated in Appendix IV.

Data included in this reported were derived from the following sources:

Goddard Weekly Report, sometimes referred to as the "Director's Weekly," published in printed form through October 14, 1994, and distributed to GSFC personnel only; denoted by "GW" in the "Reference" fields of the database records.

"Weekly Staff Notes, Office of Flight Assurance," commonly referred to as the "FAM Weekly," published in written form by Code 303 and distributed to all flight projects and to Office of Flight Assurance personnel; denoted by "FAMW" in the "Reference" fields of the database records. This report summarizes information from the Flight Assurance Managers assigned responsibilities for each GSFC flight project.

Spacecraft Orbital Anomaly Report (SOAR) database developed originally in the early 1980's and is maintained by the System Reliability and Safety Office (Code 302). The database was revised substantially in 1995 and made available to qualified GSFC users having computer access to the GSFC local area network. Each SOAR database record covers one anomaly and is assigned a "SOAR number;" e.g. C-117. Data from SOAR are denoted by the "SOAR ####."

Most projects maintain their own on-orbit anomaly records. These project sources are denoted by the corresponding report numbers, e.g., "EAR," "GIR," "HSTAR," "TOAR," etc. In some cases anomalies reported under a project source also may have been entered into the SOAR database; these have been cross-checked to avoid duplicate records for a single anomaly.

Data collected and reported herein are current with the publication date of this report. Some data regarding "open" (i.e., indeterminate or unresolved) anomalies may change after these anomaly investigations are completed. For example, an anomaly classified as Unknown (Failure Category = 6) and Indeterminate (Anomaly Type = 4) may change to different classifications after its anomaly investigation is completed.

## Summary of Spacecraft Activity during 1994

During 1994 GSFC had 27 orbiting spacecraft, including 12 launched for the National Oceanic and Atmospheric Administration. SPARTAN spacecraft are "free flyers" launched and retrieved from the Space Shuttle; the one Spartan active during 1994 is included in the anomaly report because it is a GSFC spacecraft but is not counted as an "orbital" craft. The TOMS is actually an instrument launched aboard different spacecraft; it is included in the anomaly data because of its importance to GSFC's mission (it provides atmospheric total ozone measurements). A complete listing of active GSFC spacecraft is shown in Table I, below.

Three new spacecraft launched during 1994: GOES-8 (I), NOAA-14, and Wind (GGS). The SPARTAN 201-02 was the second Shuttle launch of this free flyer; it was carried aloft in the Space Shuttle's cargo bay, "launched" for orbits of approximately 40 hours, then retrieved and returned to earth.

The COBE spacecraft was deactivated in January 1994 after its science missions were completed on

Table I  
List of Operational Spacecraft (1994)

Spacecraft	Launch Date (MM/DD/YY)	Operating Agency	Notes:
CGRO	04/05/91	NASA	Named changed to Compton Gamma Ray Observatory in 1994
COBE	11/18/89	NASA	Science mission ended 12/23/93, S/C downgraded 01/94
ERBS	10/05/84	NASA	
EUVE	06/07/92	NASA	
HST	04/24/90	NASA	
ICE (ISEE-3)	08/12/78	NASA	No 1994 anomalies
IMP-8	10/26/73	NASA	No 1994 anomalies
IUE	01/26/78	NASA	
NIMBUS-7	10/24/78	NASA	Science mission ended 12/93, S/C downgraded
SAMPEX	07/03/92	NASA	
SPARTAN 201-02	09/94*	NASA	*"Free flyer" on STS-64, returned to Earth after 40 hrs.
TDRS-1	04/04/83	NASA	
TDRS-3	09/29/88	NASA	
TDRS-4	03/13/89	NASA	
TDRS-5	08/02/91	NASA	
TDRS-6	01/13/93	NASA	
TOMS/M3	08/15/91	NASA	Instrument aboard Russian Meteor S/C; decomm'd 12/94
UARS	09/15/91	NASA	
Wind (GGS)	11/01/94	NASA	NEW
NOAA-09	12/12/84	NOAA	
NOAA-10	09/17/86	NOAA	No 1994 anomalies
NOAA-11	09/24/88	NOAA	
NOAA-12	05/14/91	NOAA	
NOAA-14	12/30/94	NOAA	NEW
GOES-2	06/16/77	NOAA	Deactivated
GOES-5	05/22/81	NOAA	Deactivated
GOES-6	04/28/83	NOAA	Deactivated
GOES-7	02/26/87	NOAA	Operational; anomalies not reported to GSFC
GOES-8	04/13/94	NOAA	NEW, Operational
LANDSAT-4	07/16/82	NOAA	No anomaly data reported to GSFC
LANDSAT-5	03/01/84	NOAA	No anomaly data reported to GSFC

December 12, 1993; the four year old craft is still in orbit and occasional communications checks are made. No anomaly data are reported for COBE. Likewise, the science mission for NIMBUS-7 ended in December 1993; the one anomaly reported for this craft in 1994 was the Santiago ground station being unable to acquire the spacecraft.

Although the Hubble Space Telescope (HST) was built under contract to Marshall Space Flight Center (MSFC), it is included in this report since management of its flight operations and servicing missions has been assigned to GSFC.

Of the GOES spacecraft still in orbit, GOES-2, -5, and -6 have been deactivated. GOES-7 and -8 are the operational satellites. Anomaly data is reported for GOES-8 but not for GOES-7; on-orbit anomalies were not reported regularly to GSFC for GOES-7.

Though they were constructed under GSFC management, the LANDSAT-4 and -5 satellites no longer have their anomalies reported to GSFC so none are included in this report.

## Spacecraft Operation Summaries

The following sections describe 1994 operations for each individual spacecraft, or series:

### Compton Gamma-Ray Observatory (CGRO) / Class B

This spacecraft, launched as the Gamma-Ray Observatory (GRO) on April 5, 1991 by the Space Shuttle Atlantis, is the largest civilian satellite ever deployed from the Shuttle - weighing in at over 17 tons. It was designed for a mission life of two years, but is expected to operate for at least six years. It is in a nearly circular, low earth orbit at 450 kilometers. The CGRO mission is to study the sources and astrophysical processes that produce the highest energy electromagnetic radiation from the cosmos. It carries four instruments that provide simultaneous observations over five decades of energy, from 0.1 MeV to 30 GeV: the Burst And Transient Source Experiment (BATSE), the Oriented Scintillation Spectrometer Experiment (OSSE), the Imaging Compton Telescope (COMTEL) and the Energetic Gamma-Ray Experiment Telescope (EGRET).

During 1994 CGRO continued to operate reliably. The three anomalies which occurred did not adversely affect science observations. By the end of 1994, CGRO had been in orbit 1370 days.

### Cosmic Background Explorer (COBE) / Class B

COBE, developed and built at GSFC, was designed to measure the diffuse infrared and microwave radiation from the early universe using three instruments: a Far Infrared Absolute Spectrophotometer (FIRAS), a Differential Microwave Radiometer (DMR) and a Diffuse Infrared Background Experiment (DIRBE). The spacecraft operated over a four year period with 21 anomalies reported by the end of 1993. It had been designed for a mission life of 18 months. On December 23, 1993, COBE's science missions were ended and the spacecraft was downgraded in its status. Several systems checks were continued through January 1994 and afterwards the satellite was deactivated. Occasional communications checks were and are still being performed. No 1994 anomalies were reported. COBE will no longer be reported in these reports.

### Earth Radiation Budget Satellite (ERBS) / None Assigned - estimated as Class B

ERBS is one of the oldest GSFC operational satellites, having 3741 days in orbit by the end of 1994. It was deployed by the Space Shuttle on October 5, 1984 into a low earth orbit which currently is 577 by 598 kilometers. It is designed to study the earth's climates. At the end of 1993, it was operating on only one

battery, which had two failed cells, and with only one command memory unit - CSM-1. During 1994, there were 16 anomalies with the remaining command memory; these usually consisted of memory locations failing validity checks and were corrected by uplinking the commands again. There was one anomaly involving a high motor current which caused a science event to be missed entirely; this anomaly was to be investigated. At the end of the year the spacecraft was still operating adequately after over ten years; it was designed originally for a two year mission life.

#### Extreme Ultraviolet Explorer (EUVE) / Class B

This “Explorer” satellite was launched June 7, 1992, aboard a Delta II launch vehicle. It is in a low earth orbit of 507 by 521 kilometers and rotates about the earth every 95 minutes. EUVE was the first satellite to make spectroscopic and wide-band observations over the entire extreme ultraviolet radiation spectrum. It consists of three scanning telescopes and a deep survey/spectrometer instrument weighing 270 and 710 pounds (188 and 323 kilograms), respectively.

During 1994, EUVE had five anomalies; four negligible or minor ones in the telemetry and data handling system and a catastrophic failure in one on-board experiment (EVEEP). In April, 1994, a transponder failed with 4414 hours total use; the system was switched to the redundant Transponder A. Three anomalies occurred with a data tape recorder, the third being a recorder failure when no tape motion was observed on December 31, 1994. The EVEEP experiment failed to provide any data on July 16, 1994; apparently, a 15 volt DC-to-DC converter failed. The experiment’s mission objectives had been met before it failed. The rest of the spacecraft was operating satisfactorily at the end of 1994.

#### Geostationary Operational Environment Satellite (GOES-8) / Class A

GOES are a series of weather and environmental observation satellites constructed and launched by NASA for the National Oceanic and Atmospheric Administration (NOAA). They provide data for severe storm evaluation, information on cloud cover, winds, ocean currents, fog distribution, storm circulation and snow melt using visual and infrared imagery; they also receive transmissions from free-floating balloons, buoys and remote automatic data collection stations around the world. GOES provides the now-familiar weather pictures seen on television newscasts. They operate in a geosynchronous orbit about 35,800 kilometers above the Earth.

GOES-8 was launched April 13, 1994, one of three orbiting GSFC satellites launched during the year. It was the first of a new generation of GOES which were designed to provide improved imaging. It is an “earth-oriented” spacecraft intended to provide more efficient duty cycles for imaging and to give higher spatial resolution and signal-to-noise ratios. Its improved sounding capability provides operational soundings from a geostationary altitude for the first time. It also featured new data transmission formats for use by direct broadcast users. These technological improvements came with a cost: GOES-8 showed the greatest number of anomalies of any spacecraft in 1994 (excluding SAMPEX). Sixty two of the 66 anomalies occurred during the testing and operational checks of the satellite. Most affected were the attitude control system (21 anomalies) and the Imager and Sounder instruments (29). Thirty nine of the anomalies were traced to design or other known, assignable causes. Thirty two of the anomalies had no effect on the spacecraft’s mission; nineteen caused some degradation in either instruments or other subsystems. Only 17 anomalies caused “minor” mission effects; none were more severe.

GOES-8 is the second of two the operational GOES craft needed to provide full coverage of the United States for National Weather Service observations. The previously launched GOES-7 provides coverage of

the western region. Anomaly data for GOES-7 was sporadically reported to GSFC, if at all, so it is not included in this year's report.

#### Hubble Space Telescope (HST) / Class B

The Hubble Space Telescope was launched from the Shuttle on April 25, 1990 into a low earth orbit at approximately 600 kilometers. Its two well-known post-launch problems, the aberration in its telescope mirror and a solar array affecting its instruments, have both been resolved with the first servicing mission in 1993.

HST had 19 anomalies during 1994, none which caused more than "minor" effects to its mission. The anomalies affected the attitude control (4), power (3), telemetry and data handling (4), timing command and control (4) and scientific instruments (4). One solar panel assembly shorted and decreased power to battery number 5; its projected impact would not affect science missions until March 2000 if the array is not replaced by that time. Five days of science observations were lost in October when the Faint Object Spectrograph (FOS) went into an automatic SAFE mode; this possibly was caused by a transient which corrupted the FOS microprocessor. In December gyroscope number 5 showed two occasions of excessive current. It was suspected to be a "lubricant patch" problem and the gyroscope was to be monitored and shut down if its current exceeded 240 mA; this would not affect the science missions as a redundant gyroscope would be switched in. Most other anomalies were memory and computer errors. At the end of 1994, HST was operating satisfactorily.

#### Interplanetary Monitoring Platform (IMP-8) / None Assigned - estimated as Class C

IMP-8 was launched on October 26, 1973, into a 189,024 by 247,267 kilometer orbit. It measures magnetic fields, plasmas, and energetic charged particles (e.g., cosmic rays) of the Earth's magnetotail and magnetosheath and of the near-Earth solar wind. IMP-8 operated satisfactorily during all of 1994 and continued to operate through June 1996. No anomalies were reported during 1994.

#### International Cometary Explorer (ICE) / None Assigned - estimated as Class B

This satellite was launched August 12, 1978, to study the composition and physical state of a comet's nucleus and to investigate interactions between the solar wind and cometary atmosphere. In August, it celebrated its sixteenth year in orbit. No anomalies were reported in 1994; only Jet Propulsion Laboratory investigators are receiving data from the satellite, since funding was transferred to JPL in February 1993.

#### International Ultraviolet Explorer (IUE) / None Assigned - estimated as Class B

This spacecraft is the second oldest operating spacecraft in this report, having been launched on January 26, 1978 into a 30,237 by 41,354 kilometer synchronous orbit by a Delta launch vehicle. It is 4.2 x 1.45 x 1.45 meters in size and weighs 462 kg (in orbit). It had been in service for seventeen years in January 1995, with a design life of three years. It is a "workhorse" observatory and gathers data on planets, stars, galaxies and "targets of opportunity," such as comets, novae and supernovae. During July, 1994, IUE spent a significant time observing Jupiter when the Comet Shoemaker-Levy collided with that planet. IUE often is used in conjunction with other observatories (such as Hubble Space Telescope, the German ROSAT, CGRO, EUVE and other space- and ground-based probes) to accumulate simultaneous data.



During 1994 IUE suffered eleven anomalies in its TC&C system in which commands were not received or executed properly; these were re-uplinked and executed successfully. There was one attitude system anomaly in which the spacecraft's pitch and yaw varied; this was stabilized the following day after new gyroscope trim commands were uplinked. In another case, a pitch axis reaction wheel changed without any consequent spacecraft attitude change and this was cleared by switching the telemetry to another command unit. At the end of 1994 IUE still was operating satisfactorily.

Landsat / None Assigned - estimated as Class B

The Landsat series of satellites provide mapping of the Earth's features through transmissions of global pictures recorded in a number of wavelengths, or spectral bands. Landsat images are used for many diverse scientific applications, such as providing maps and charts of regions previously too remote for conventional mapping, locating sea life sources, minerals and fresh water, evaluating forestation and agriculture, and so forth. Landsat anomaly data is no longer provided to GSFC, so none are included in this report.

NIMBUS-7 / None Assigned - estimated as Class B

This old spacecraft, launched in 1978, provided television and infrared imaging for weather analyses from a near polar orbit. It also carried the first TOMS instrument that provided most of the data for the study of global ozone and the "ozone hole" over the Antarctic; this instrument ceased functioning in May 1993. Its science mission was ended on December 28, 1993, when the sun angle on the solar arrays was such that insufficient power was generated to run the two remaining instruments. The spacecraft continued to operate as a communications relay link until April 11, 1994, when the Santiago ground station was no longer able to acquire the spacecraft. Nimbus-7 will no longer be reported in subsequent reports.

National Oceanic and Atmospheric Administration (NOAA) / Class B

The NOAA-series of spacecraft are a more advanced version of the previous TIROS-series which provides television and infrared imaging for weather forecasting and environmental studies. Additionally, they provide search and rescue capabilities through continuous, worldwide monitoring for distress radio beacons; these services are coordinated through the cooperative efforts of many nations. The NOAA satellites are constructed and launched by NASA for the National Oceanic and Atmospheric Administration (NOAA).

In 1994 there were four active NOAA satellites: NOAA-09, -10, -11, and -12. NOAA-14 was launched on December 30, 1994. NOAA-09 suffered one anomaly in August - failure of its Z-axis reaction wheel after a large pitch attitude transient. NOAA-10 had no 1994 anomalies. NOAA-11 had three anomalies: an increase in AVHRR motor current in its power system, drive transistors overheating in an instrument and a diffuser not being stowed. NOAA-12 also had three anomalies: two were related to the skew gyroscope and a the third involved the telemetry and data handling system for its microwave sounding unit. The newly launched NOAA-14 had two anomalies involving its attitude control system: a gas regulator leak caused an attitude disturbance and there was an un-neutralized thrust vent when a gaseous nitrogen valve was opened to relieve pressure in its system. None of the nine NOAA anomalies caused an impact more severe than "minor."

## Solar Anomalous and Magnetospheric Particle Explorer (SAMPEX) / Class C

SAMPEX is the first spacecraft launched under GSFC's Small Explorer Program. It was launched July 3, 1992, aboard a Scout expendable launch vehicle into a 520 by 670 kilometer orbit. It is designed to study the composition of energetic particles arriving at Earth from the solar atmosphere and interstellar space. It also measures the number of relativistic electrons entering the atmosphere from outer space which contributes to ozone destruction.

The spacecraft uses several innovative approaches including an optical fiber bus, powerful on-board computers and large solid state memories (instead of the tape recorders usually employed). SAMPEX is designed for a mission life of three years.

The SAMPEX project did not catalog and record its anomalies in a format consistent with the other GSFC projects. It reports all anomalies, though many are insignificant when compared to their impact on spacecraft operations. Also, they do not classify them by criticality, or mission effect, anomaly effect, anomaly type and failure category. Thus, the 161 SAMPEX anomalies reported in 1994 are discussed separately from the other GSFC satellites in this report.

## SPARTAN 201-02 / Class D

SPARTAN 201 is a small, Shuttle-launched and -retrieved satellite designed to study the Sun. It is 2.3 m long and weighs 1136 kg (deployed mass). SPARTAN 201 carries two instruments, a White Light Coronagraph (WLC) and a Ultraviolet Coronal Spectrometer (UVCS). The -02 after the 201 designation refers to its sequential flight number.

SPARTAN 201-02 was flown aboard STS-64 in September 1994. The WLC instrument failed when its images saturated. This was caused by a design decision to use a larger external occulting disk; the originally-sized disk was refitted for the -03 mission in 1995 and the instrument functioned perfectly.

## Tracking and Data Relay Satellite (TDRS) / Class A

The TDRS satellites provide communications for NASA and other satellites and for the Space Shuttle. Using two TDRS positioned in orbits of about 35,900 kilometers altitude and 130 degrees apart NASA is able to provide better coverage (85 to 100% of an orbit, depending on the user satellite's orbital altitude) without the extensive network of ground stations formerly used. They can handle up to 300 million bits of information per second. Each TDRS weighs about 2086 kilograms and are 17 m wide (across the solar arrays). The satellite's solar panels provide 1700 Watts of power.

In 1994, there were five active TDRS satellites. TDRS-1, -3, and -6 each had one anomaly, all which had a negligible impact on their mission. TDRS-4 had two "negligible" anomalies: a change in Command Processor B's decoder address, which was reset and verified, and a drop in the TLM signal for a TWTA, which also was resolved. TDRS-5 had two anomalies in May caused by failure of one TWTA; service was switched to the other redundant TWTA. At the end of 1994, operation of all five TDRS satellites was nominal.

## Total Ozone Mapping Spectrometer (TOMS - M3) - INSTRUMENT / Unknown

The TOMS instrument was included in this report because of its importance to GSFC's mission. TOMS is an instrument launched aboard a spacecraft which performs high resolution mapping of global ozone on a daily basis. It is the primary source for high resolution global maps of the ozone content of the Earth's atmosphere; it also has provided pictures of the Antarctic "ozone hole." In additions, TOMS measures sulfur dioxide, such as that released in volcanic eruptions. The TOMS instruments have provided scientists valuable data which separates out the short term and long term fluctuations in atmospheric ozone.

The first TOMS was launched aboard NIMBUS-7.

The TOMS instrument included in this report was launched August 15, 1991, aboard a Russian (then Soviet Union) Meteor-3 spacecraft. It functioned satisfactorily until the instrument's chopper motor began to show anomalous current readings in 1993. The motor finally failed completely on December 23, 1994, at which time TOMS-M3 ceased providing data. It was suspected that the bearing may have failed in the motor.

## Upper Atmosphere Research Satellite (UARS) / Class B

UARS is the first major spacecraft of NASA's Mission to Planet Earth series, a coordinated long-term program studying the Earth's global environmental systems. It was launched on September 15, 1991, from the Space Shuttle Discovery. It contains ten simultaneously-operating scientific instruments for studying the composition, temperature, winds and energy of the stratosphere, mesosphere and lower thermosphere; eight of the instruments are still operating. UARS provided the first global map of chlorine monoxide, confirming a direct link between its presence and ozone depletion. At the end of 1994, it had been operating for three years and three months, exceeding its design life of three years.

During 1994, UARS suffered seven anomalies affecting its attitude control, power, telemetry and data handling, TC&C, and instrument systems. None had more than a "minor" impact. They included noise in Transponder A (January 6 and March 5) and a loss of some atmospheric data on January 19 when the MLS scan system intermittently responded to commanded position changes. A low voltage/low charge condition in a battery caused a large spacecraft current load on February 26; this was remedied and the spacecraft returned normal operations within 24 hours by operational commands. Yaw commands failed to be executed on March 15, which caused a consequent load-shedding and turned off most instruments; this was fixed by rescheduling the yaw maneuver for the following day. At the end of 1994, UARS was operating satisfactorily with eight operational instruments.

## Wind (Global Geospace Science - GGS) / Class B

Wind is the first of two spacecraft in GSFC's Global Geoscience (GGS) initiative. It is designed to observe the Earth's "foreshock region" and to measure the incoming solar wind and magnetic fields and particles. It was launched November 1, 1994, aboard a Delta launch vehicle.

The first 30 days of Wind operations were used for spacecraft and instruments checkouts. The spacecraft began science operations after this initial thirty days. Wind reported six anomalies, none of which had more than a "negligible" effect on its mission. One thruster provided only 75% of its expected thrust during a calibration maneuver on the first day of its mission; this thruster was not used for the balance of the reporting period. There was an anomalous valve cooling incident, in which a valve remained at a high temperature for over one hour and then rapidly cooled; it was suspected to have been caused by an

operational amplifier latching up (a design problem). There were three instrument anomalies: the SWE instrument shut down because of a current overshoot, the SWE reset itself to an emergency turn-off when there was an extraneous command in its SCT unit and commands up-linked to the TGRS instrument caused it to reset. In all cases, the instruments returned to full operation. At the end of 1994, Wind spacecraft was performing satisfactorily.

## Detailed Anomaly Data

Anomaly data for this report were classified using the same categories as for previous reports in this series and which also correspond to the categories and classifications used for data in the older Spacecraft Orbital Anomaly Report (SOAR) database. This classification scheme assigns numerical codes to various categories to facilitate data entry, sorting and analysis of the anomaly data. The classification categories are as follows:

1. Spacecraft Mission Classification - Assigned A, B, C, or D in accordance with the NASA mission level per GMI 8010.2. In some cases, the mission classification may not be listed if it is not known, e.g., if the spacecraft were launched before the above classification scheme was implemented.
2. Index - A sequential reference number assigned chronologically from the launch for each spacecraft or spacecraft series enumerating reported anomalies. For this year's report, the index numbers are prefixed by "94" to denote the year the anomalies occurred, e.g., "9417" is the seventeenth anomaly reported since launch and it occurred during 1994.
3. Date - The date an anomaly occurred is reported as "YYMMDD," to facilitate database sorting. The corresponding number of days since launch, if known, is reported as "#Days."
4. Subsystem - Spacecraft systems (or subsystems) are classified into the following nine categories:
  - 1 = Attitude Control System (ACS)
  - 2 = Power System
  - 3 = Propulsion System
  - 4 = Spacecraft Structure
  - 5 = Telemetry and Data Handling System (TLM & DH)
  - 6 = Thermal System
  - 7 = Timing, Command and Control System (TC&C)
  - 8 = Instrument(s) (spacecraft payload)
  - 9 = Other system, not listed above
5. Criticality (Mission Effect) - A number denoting the effect of the anomaly on the spacecraft's mission is assigned according to the following classifications:
 

1 = Negligible, or no impact	(approx. 0 - 5 % of the mission objectives)
2 = Minor (not negligible, small)	( 5 - 33 %)
3 = Substantial (1/3 to 2/3 mission loss)	(33 - 66 %)
4 = Major (2/3 to nearly total loss)	(66 - 95 %)
5 = Catastrophic (Total mission loss)	(95 -100 %)

5. Description - A brief description of the anomaly and its probable cause, if known.
6. Effect or Action - The anomaly's effect on the mission and corrective action for this or future missions, if known.
7. Reference - The information source, or sources, for the anomaly, e.g., project anomaly or incident report number, SOAR number, or other document.

Each anomaly also is classified under the following criteria for sorting and analysis in the Spacecraft Orbital Anomaly Report (SOAR) database:

- |                            |   |
|----------------------------|---|
| Anomaly Effect:            | <ul style="list-style-type: none"> <li>1 = Spacecraft failure</li> <li>2 = Subsystem or Instrument failure</li> <li>3 = Component failure</li> <li>4 = Assembly failure</li> <li>5 = Part failure</li> <li>6 = System or instrument degradation</li> <li>7 = Indeterminate (not known)</li> <li>8 = Loss of redundancy</li> <li>9 = None</li> </ul> |
| Failure Category:          | <ul style="list-style-type: none"> <li>1 = Design problem</li> <li>2 = Workmanship problem</li> <li>3 = Part problem</li> <li>4 = Environmental problem</li> <li>5 = Other cause (known, with explanation)</li> <li>6 = Unknown</li> </ul>  |
| Anomaly Type:<br>equipment | <ul style="list-style-type: none"> <li>1 = Systematic (i.e., anomaly would occur for identical<br/>operated under identical conditions)</li> <li>2 = Random</li> <li>3 = Wearout (special case of "Systematic")</li> <li>4 = Indeterminate (not known)</li> <li>5 = Intermittent</li> <li>6 = Normal or expected operation</li> </ul>               |

### Summary of Detailed Anomaly Data

For GSFC's 1994 spacecraft operations, there were 27 active spacecraft. A total of 310 anomalies were reported among 21 satellites and one instrument (TOMS). These included 66 anomalies on GOES-8 and 155 on SAMPEX. SAMPEX anomalies are discussed separately from other GSFC satellites in a separate section, below.

The distribution of anomalies among the non-SAMPEX spacecraft is shown in Table II, below. Since GOES-8 accounted for 43% of the anomalies, Table II and the other tables show two separate classification totals: "All S/C except GOES-8" and "All S/C." For the NOAA and TDRS satellites, the

Table II. 1994 Anomaly Distribution Among Spacecraft

S/C	Number of Anomalies		S/C	Number of Anomalies	
	1994	life time		1994	life time
CGRO	3	23	NOAA-9/14	9*	82*
ERBS	17	38	SAMPEX	155	297
EUVE	5	6	SPARTAN 201-02	1	-
GOES-8	66	66	TDRS-1/6	7*	139*
HST	19	91	TOMS (Instrum.)	1	-
IUE	13	45	UARS	7	17
NIMBUS-7	1	75	Wind	6	6
Total				310	-
Total (excl. SAMPEX)				155	-

\* Includes all S/C in the series.

Table III. 1994 Anomaly Distribution by Mission Effect

Mission Effect =	1	2	3	4	5
S/C	(0 - 5%)	(5 - 33%)	(33 - 66%)	(66 - 95%)	(95 - 100%)
CGRO	3				
ERBS	3	14			
EUVE	2	2			1
GOES-8	49	17			
HST	16	3			
IUE	12	1			
NIMBUS-7					1
NOAA-9/14 *	1	7			
SPARTAN 201-02				1	
TDRS-1/6	5	2			
TOMS (Instrum.)					1
UARS	5	2			
Wind	6				
All S/C except GOES-8	53	31	0	1	3
All S/C	102	48	0	1	3

Note: SAMPEX data NOT included in above table.

\* - One NOAA-11 anomaly not classified.

tables include totals for all active spacecraft within each series. For reference, Table II lists both the number of 1994 anomalies and the total number since launch (“life time”).

The GOES-8 spacecraft showed an unusually large number of anomalies compared to the other spacecraft. This was the first “new generation” GOES, which historically had integration and test problems before it was launched. Sixty two of the 66 anomalies reported in 1994 occurred during the operational “check out and testing” of the newly launched craft. Particularly troublesome were its Attitude Control System (21 of 66 anomalies) and Instruments (or Payload) (29 of 66), see Table IV. These two subsystems accounted for 76% of the GOES-8 anomalies.

Table III shows anomaly effects on each spacecraft’s total mission. Sixty six percent of the anomalies (102) had little or no effect (“negligible, or no impact”) on spacecraft mission performance and 31% had a “minor” effect (5 to 33% of the mission). Only four anomalies affected greater than 66% of spacecraft missions. These included a total instrument failure of the EVEEP experiment on EUVE (however, all mission objectives had been met before failure); a communications failure between the ground station (Santiago) and NIMBUS-7 (after four attempts) resulting in a loss of the remaining spacecraft mission (this satellite had its science mission terminated on December 23, 1993, and was being used only as a communications relay link); failure of the White Light Coronagraph (WLC) instrument on SPARTAN 201-02, caused by a design decision (to fit an oversized occulting disk to the instrument for this flight); and failure of the chopper motor on the TOMS instrument aboard the Russian Meteor-3 spacecraft.

The anomaly distribution among spacecraft subsystems is shown in Table IV. GOES-8 already has been discussed above. For all other spacecraft, the most anomalies occurred in the Timing, Command and Control (TC&C) systems (36 anomalies, 40%), Telemetry and Data Handling systems (12, 13%), Instruments (15, 17%) and Attitude Control Systems (ACS) (12, 13%). ERBS and IUE accounted for 27 of the 36 TC&C anomalies; both spacecraft historically have had problems reading commands into their on-board memories and these problems are resolved easily by “reloading” or “re-uplinking” the commands up to the memories.

Table V shows the distribution among anomaly effects, or how the anomalies affected the entire spacecraft. For GOES-8 thirty eight percent (19 anomalies) caused instrument or subsystem degradation; 48% (32) had no effect on systems and for 18% (12) the anomaly effects were undetermined. For other spacecraft, 28% (25) caused instrument or subsystem degradation and half the anomalies were either “not determined” or showed “no effect” - 31 and 14 anomalies, respectively.

Anomaly distribution by “types” is show in Table VI. More than half (82 anomalies, 53%) were “not determined.” Twenty three percent (35) were “systematic” effects, 12% (10) were “random” effects and 10% (15) were classified as “expected operation.”

Failure categories were determined for 54% of anomalies (83). Of these, Table VII shows that 60% (50 of 83) were caused by design problems and 42% (35 of 83) were caused by “other known” problems. This is a significant fact, as it shows that almost 70% of the 1994 “determined” anomalies have an assignable cause which could be eliminated during design or manufacture. Only 8% of the anomalies were affected by environmental factors (i.e., the space environment) However, almost half (72) of the anomalies had not been classified by failure category.

Figures 1 through 6, on pages 16 through 18, graphically display the anomaly data from Tables II through VII.

Table IV. 1994 Anomaly Distribution Among S/C Subsystems

S/C Subsystem =	1	2	3	4	5	6	7	8	9
S/C									
CGRO					3				
ERBS							16	1	
EUVE					4			1	
GOES-8	21	6	1		2	1	4	29	2
HST	4	3			4		4	4	
IUE	1				1		11		
NIMBUS-7							1		
NOAA-9/14	5	1			1			2	
SPARTAN 201-02								1	
TDRS-1/6	1				2		2	1	1
TOMS (Instrum.)								1	
UARS	1	1			2		1	1	1
Wind			1			1	1	3	
All S/C except GOES-8	12	5	1	0	17	1	36	15	2
All S/C	33	11	2	0	19	2	40	44	4

Note: SAMPEX data NOT included in above table.

## SUBSYSTEMS:

- |                      |                               |                              |
|----------------------|-------------------------------|------------------------------|
| 1 - Attitude Control | 4 - Structure                 | 7 - Timing Control & Command |
| 2 - Power            | 5 - Telemetry & Data Handling | 8 - Instrument (Payload)     |
| 3 - Propulsion       | 6 - Thermal                   | 9 - Other                    |

Table V. 1994 Anomaly Distribution by Anomaly Effect

S/C Subsystem =	1	2	3	4	5	6	7	8	9
S/C									
CGRO							2	1	
ERBS							17	1	
EUVE			3	1		1			
GOES-8	1	1				19	12	1	32
HST				3		10	4	2	
IUE						1	5		7
NIMBUS-7	1								
NOAA-9/14		2				6	1		
SPARTAN 201-02		1							
TDRS-1/6						3		2	2
TOMS (Instrum.)		1							
UARS						2	2	1	2
Wind						2		1	3
All S/C except GOES-8	1	4	3	4		25	31	7	14
All S/C	2	5	3	4		44	43	8	46

Note: SAMPEX data NOT included in above table.

## Anomaly Effects:

- |                                   |                                   |                              |
|-----------------------------------|-----------------------------------|------------------------------|
| 1 - S/C Failure                   | 4 - Assembly Failure              | 7 - Unknown (Not determined) |
| 2 - Subsys. or Instrument Failure | 5 - Part Failure                  | 8 - Loss of Redundancy       |
| 3 - Component Failure             | 6 - Subsys. or Instr. Degradation | 9 - None                     |



Table VI. 1994 Anomalies by Anomaly Type

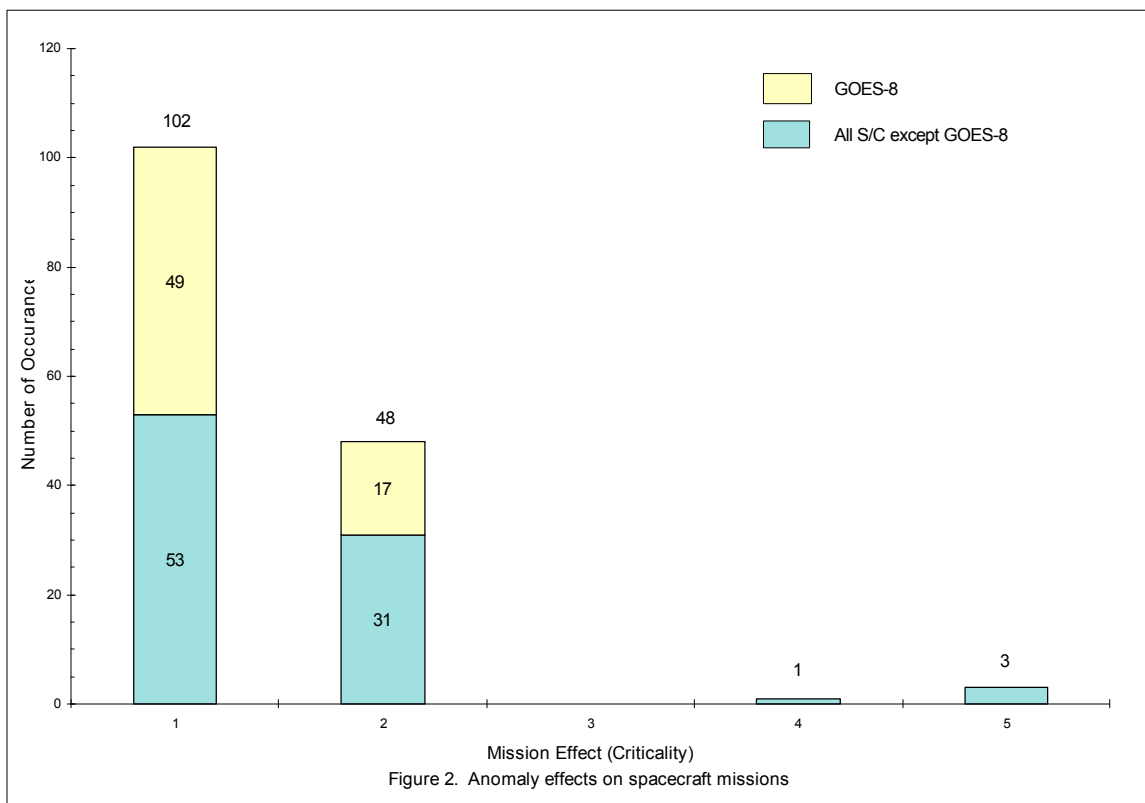
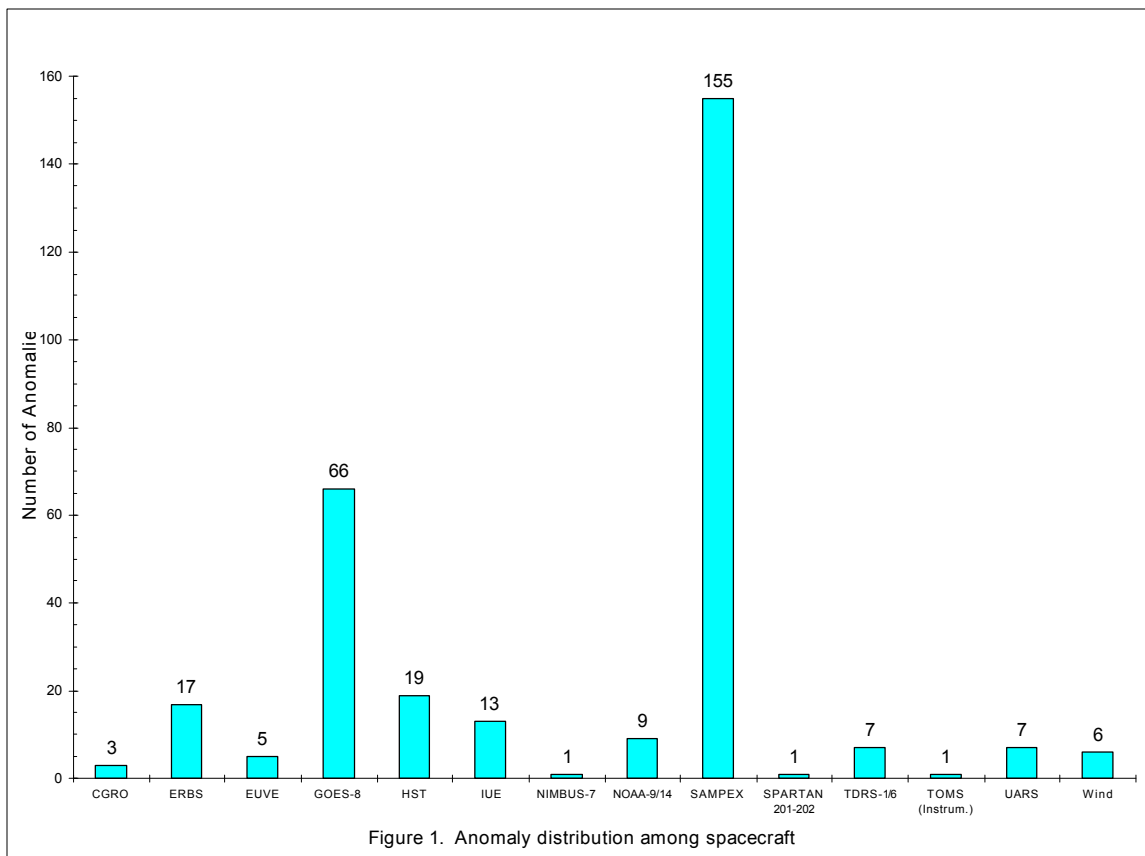
Anomaly Type =	1	2	3	4	5	6
S/C	Systematic	Random	Wearout	Indeterminate	Intermittent	Expected Op'n
CGRO				3		
ERBS				17		
EUVE		2		3		
GOES-8	25	5		19	2	15
HST		9		9	1	
IUE				13		
NIMBUS-7				1		
NOAA-9/14 *	2			7		
SPARTAN 201-02	1					
TDRS-1/6	2	1	1	3		
TOMS (Instrum.)				1		
UARS	2			5		
Wind	3	2		1		
All S/C except GOES-8	10	14	1	63	1	0
All S/C	35	19	1	82	3	15

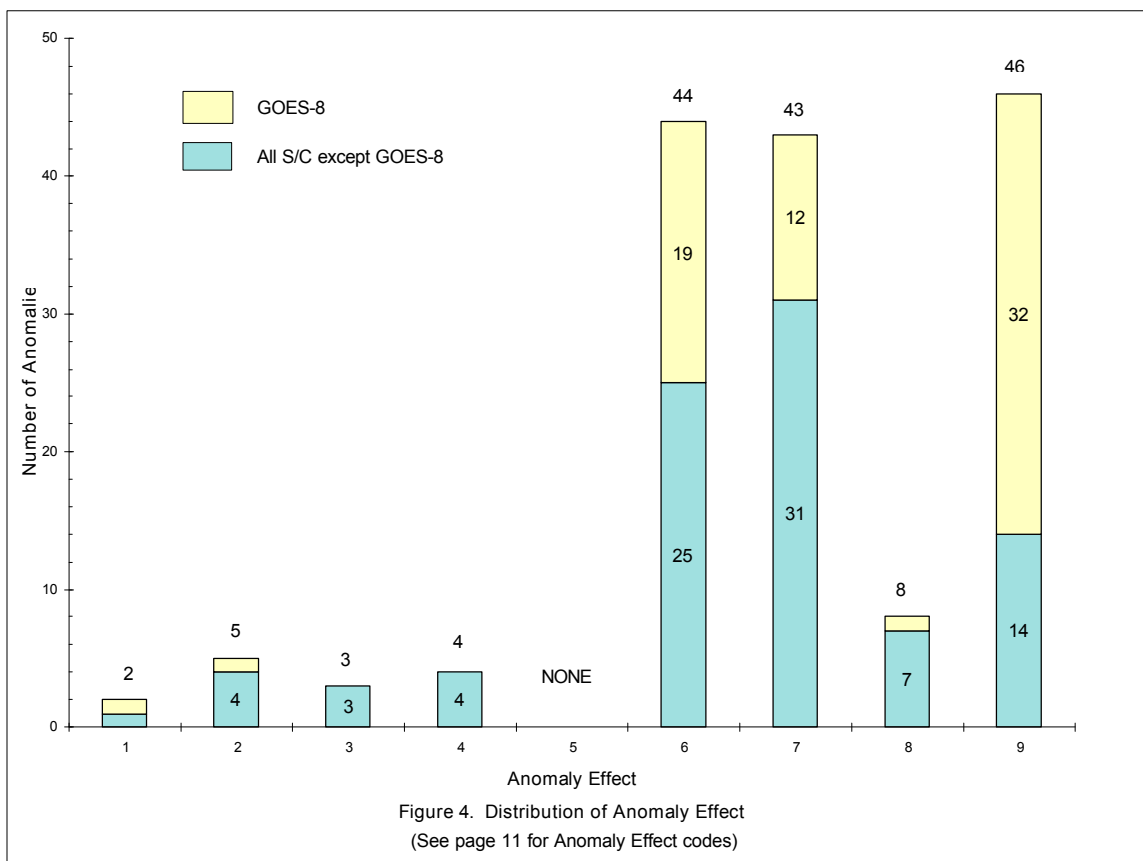
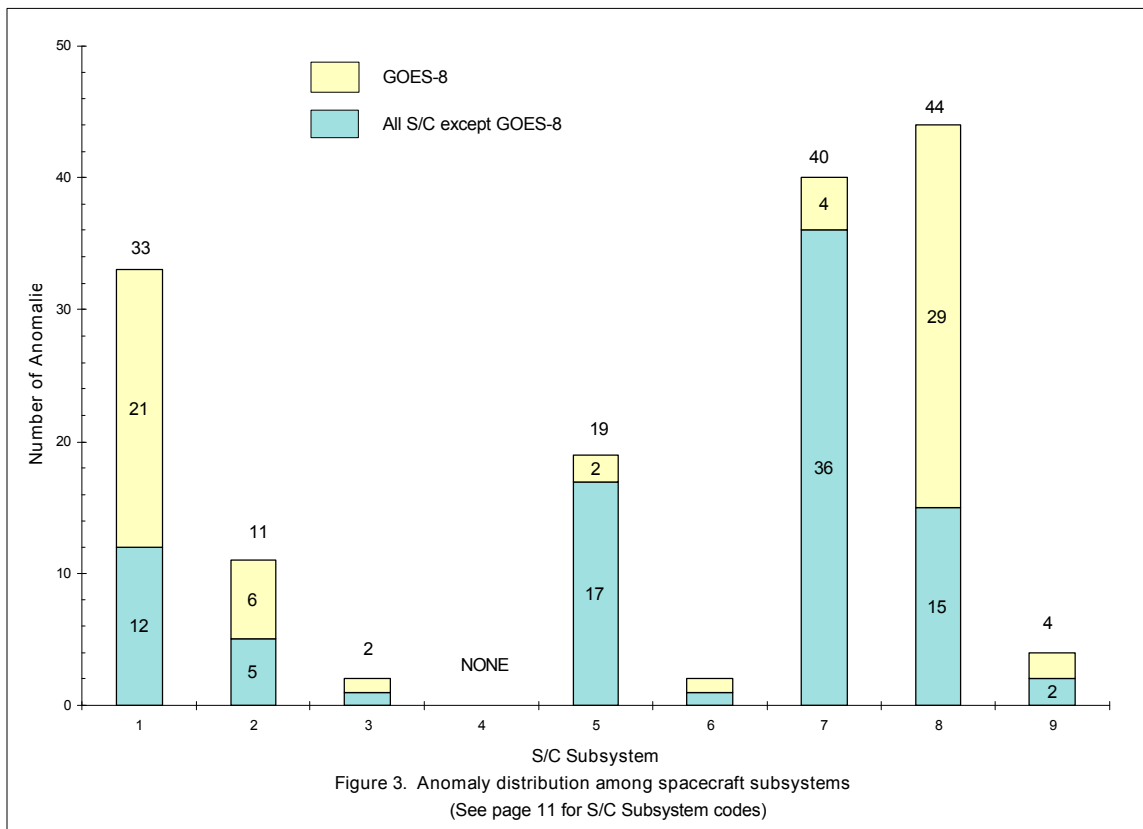
Note: SAMPEX data NOT included in above table.

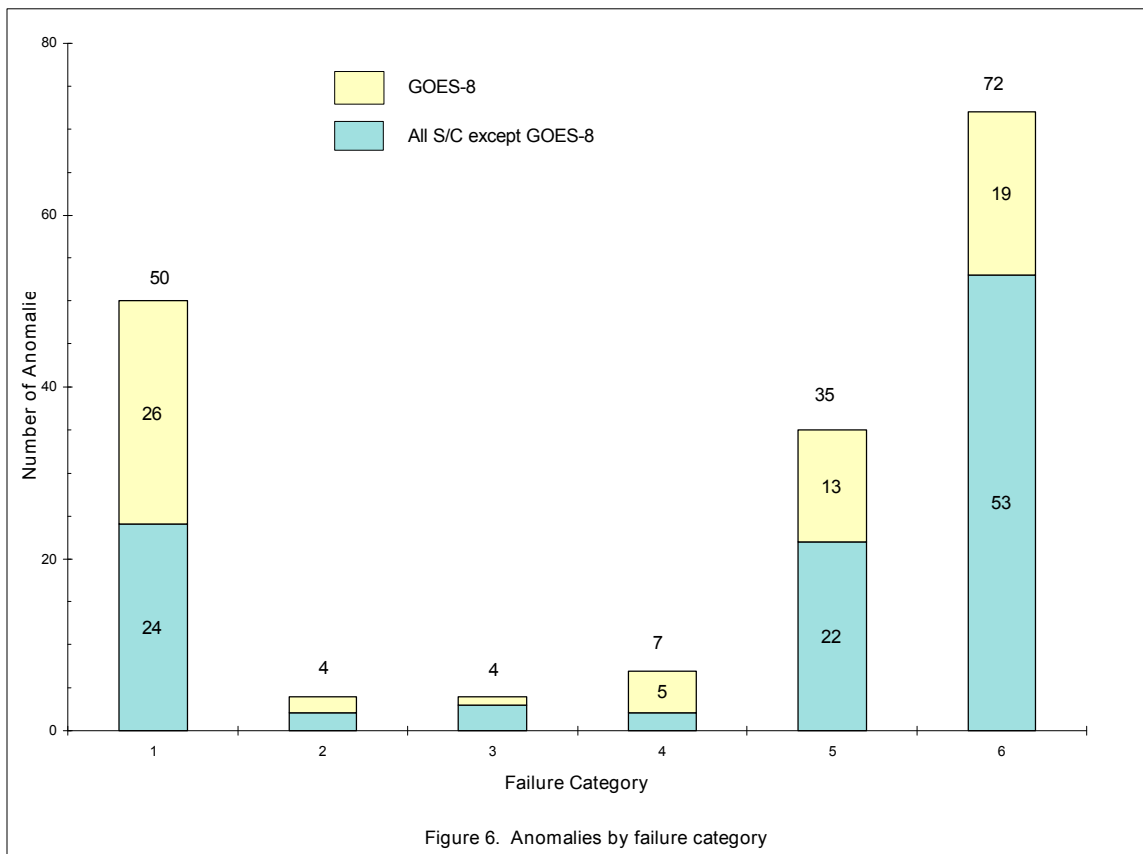
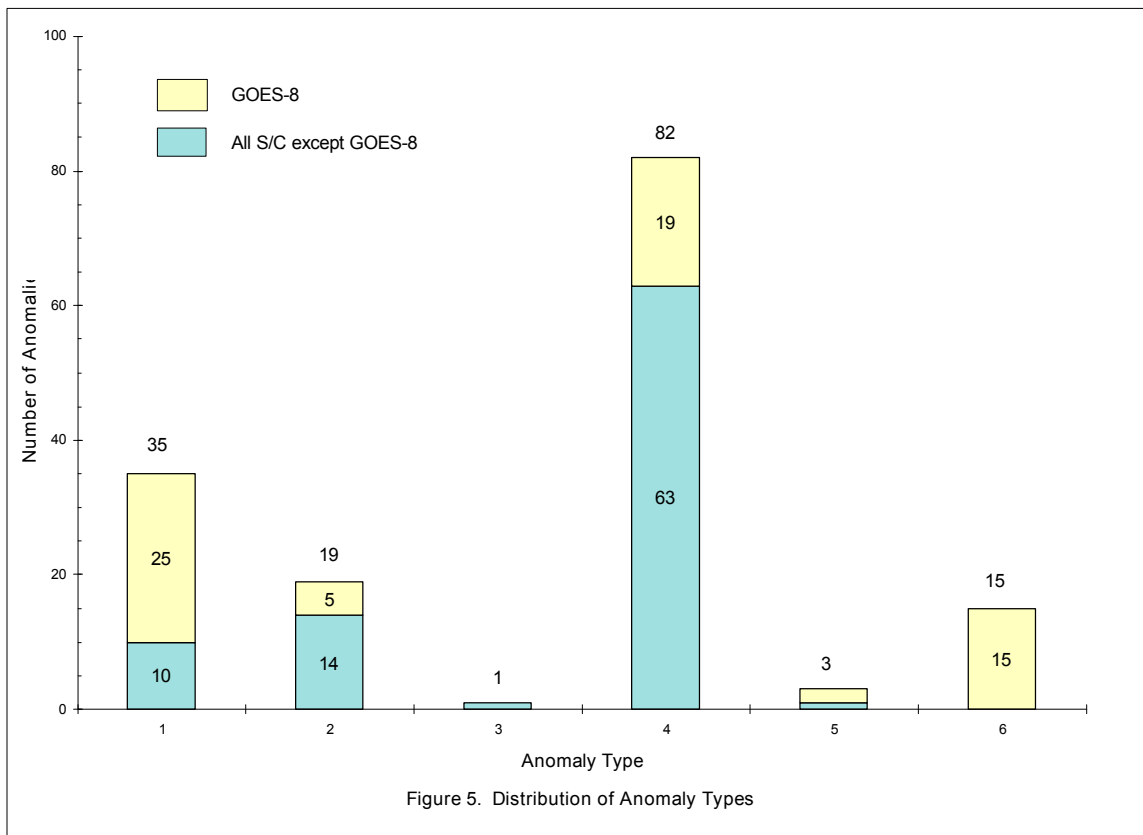
Table VII. 1994 Anomalies by Failure Category

Failure Category =	1	2	3	4	5	6
S/C	Design Problem	Workmanship Problem	Part Problem	Environmental Problem	Other (Known)	Unknown
CGRO						3
ERBS	16				17	
EUVE	1					4
GOES-8	26	2	1	5	13	19
HST	3	1	1	1	1	13
IUE						13
NIMBUS-7						1
NOAA-9/14 *			1		1	7
SPARTAN 201-02	1					
TDRS-1/6			1	1	1	4
TOMS (Instrum.)						1
UARS					2	5
Wind	3	1				2
All S/C except GOES-8	24	2	3	2	22	53
All S/C	50	4	4	7	35	72

Note: SAMPEX data NOT included in above table.







## SAMPEX Anomaly Data

As mentioned above, 1994 SAMPEX anomalies are reported in this separate section.

SAMPEX reported 155 anomalies during 1994. Because their reporting system does not classify their anomalies like the other projects, their data is less detailed. Anomalies are classified only by “subsystem,” their reports do not classify the anomalies by criticality (mission effect), anomaly type and effect or failure category. SAMPEX anomaly reports cite a “Subsystem,” but they do not assign a numerical code - the codes listed in this report were those assigned by this author based on the subsystem cited in the reports.

Most SAMPEX anomalies occurred in its instruments (56), attitude control system (40) and telemetry and data handling system (37), which includes its on-board computer (SEDS). The complete distribution of anomalies is shown in Table VIII, below.

Table VIII. 1994 SAMPEX Anomaly  
Distribution Among S/C Subsystems

Subsystem	Number
(1) Attitude Control System	40
(2) Power	11
(3) Propulsion	0
(4) Structure	0
(5) Telemetry & Data Handling	37
(6) Thermal	5
(7) Timing, Command & Control	4
(8) Instruments	55
(9) Other	1
Total	154

Note: One anomaly not classified

Whether SAMPEX really experienced 155 “anomalies” in 1994 is unclear from their reports. Each report does list an anomalous behavior of the spacecraft. However, it appears the project has no mechanism for corrective actions which would ameliorate the spacecraft’s propensity for anomalous behaviors. For example, Monitors 15 and 16 for the LEICA instrument showed 32 separate occurrences for out of limit (OOL) behavior during the year, yet the “Resolution or Disposition” block of their reports listed simply “known anomaly.” Evidently, this is a recurring error flag which apparently does not affect the spacecraft’s overall performance, but which results in an anomaly report being written.

Half of all SAMPEX anomalies (77 of 155) were either “known anomalies” or ones previously reported. Another 18 occurrences were caused by known spacecraft environmental conditions (“full sun season” or “eclipse”) for which telemetry flagged various systems for anomalous indications although the effects were known and caused no permanent spacecraft degradation. Apparently, most of the reported anomalies are known behaviors of the spacecraft and its systems which do not adversely affect its science missions. Only three instances were reported in which the spacecraft lost data (index numbers 94276, 94277 and 94288).

## GSFC Spacecraft Lifetime Data

Appendix IV is a performance summary for all GSFC spacecraft from 1960 through December 1994. Four spacecraft were added for this year's report: GOES-8, SPARTAN 201-02, Wind and NOAA-14.

Figures 7 and 8 illustrate the historical performance of GSFC spacecraft. Figure 7 compares the actual years of service and the active on-orbit life (in years) with spacecraft designed life ("planned years of service") over four decades: 1960-1969, 1970-1979, 1980-1989 and 1990-1994. For the first three decades, GSFC spacecraft lifetimes ranged from 1.2 to 3.9 and 1.5 to 4.5 times the design life for their useful ("actual years of service") and active lives, respectively. Note that the 1990-1994 data are incomplete at this time, since most of these spacecraft are still active and their "useful" and "active" lives have not yet been established. The calculations assumed service lives to the current date (1994) to complete the data. In some cases, this caveat also applies to the 1980-1989 data, since nine of the twenty one spacecraft launched are still active in 1994.

Figure 8 shows the percentage of GSFC spacecraft attaining 3 years, 4 to 5 years, 6 to 7 years and 8 to 10 years of useful life versus the year of launch. This is essentially a "reliability growth curve." Early years showed fewer satellites attaining three-year lifetimes, but these improved to 70 to 80 percent by the late 1960's and early-1970's. What is significant is that the earliest spacecraft were designed for only 0.25 to 1.00 year lifetimes, so achieving spacecraft lifetimes of three years or more is a testament to the reliability of these early craft.

The above two figures represent two different analyses performed on GSFC spacecraft performance. Another insight into GSFC spacecraft performance is presented in the report GSFC Spacecraft Reliability (1970-1994), cited in the references below. This report compares historical performance against mission classifications, orbital altitudes, spacecraft size and quality classification.

### Acknowledgments

J. Remez provided many suggestions, furnished Figures 7 and 8, and reviewed the manuscript; his guidance was instrumental in publication of this report. The following people assisted by providing information used in compiling this report: Susan Adams (ARC), P. K. Bhartia (Code 916), David Bradley (ATSC), Edward Carty (MDA), Dennis Chesters ((913), Sandra D'Orazio (EER), John Jackson (510), Adam Johnson (ATSC), James Lohr (311), W. (Bill) Mazur (NOAA), Doug McCuistion (415), Paul Pashby (602), Robert Peavler (480), Phillip Sabelhaus (415), Mark Steiner (740), Karen Temple-True (NOAA), Craig Tooley (741), and Darrel Williams (923). All their contributions were instrumental in the publication of this report.

### References:

- GSFC Goddard Management Instruction 8010.2 , "Classification of GSFC Orbital Flight Projects and Determination of Commensurate Performance Assurance Requirements," Goddard Space Flight Center, Greenbelt, Maryland, April 1990, 6 pp.
- GSFC Spacecraft Reliability (1970-1994) , report prepared for the GSFC System Reliability and Safety Office (Code 302) by Hernandez Engineering, Inc., Greenbelt, Maryland, December 30, 1994, 26 pp.
- Mission Operation Report , "Wind Laboratory Quarterly Status Report for the period November 1, 1994 to January 31, 1995," CDRL 226, Martin Marietta Corporation, Astro Space Division, Princeton, New Jersey, Contract Number NAS5-30503, March 1, 1995, 81 pp.
- Orbital Anomalies in Goddard Spacecraft for CY1993 , prepared for the GSFC System Reliability and Safety Office (Code 302) by Hernandez Engineering, Inc., Lanham-Seabrook, Maryland, June 1994, 41 pp.

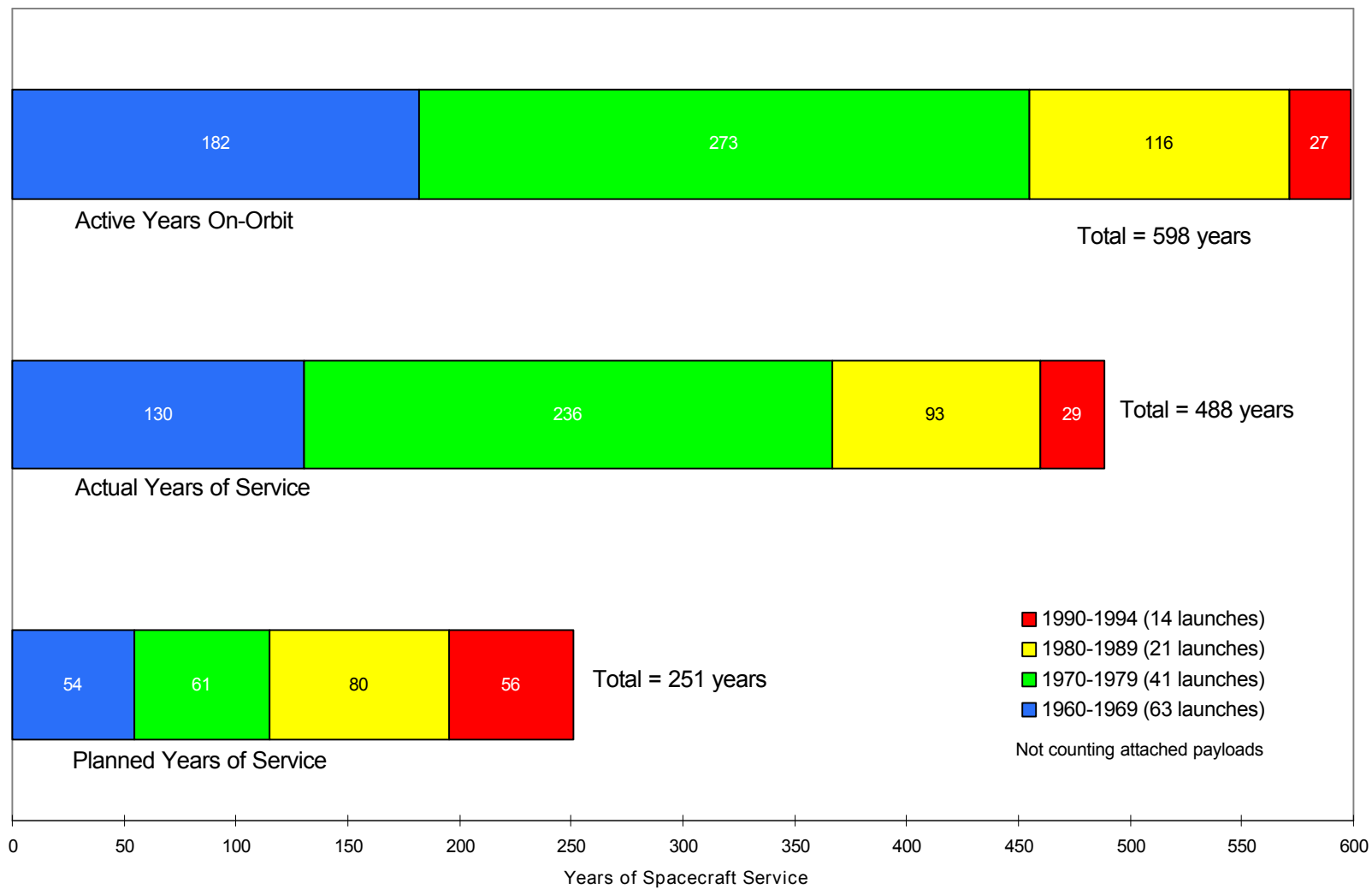


Figure 7. GODDARD SPACECRAFT LONGEVITY THROUGH 1994

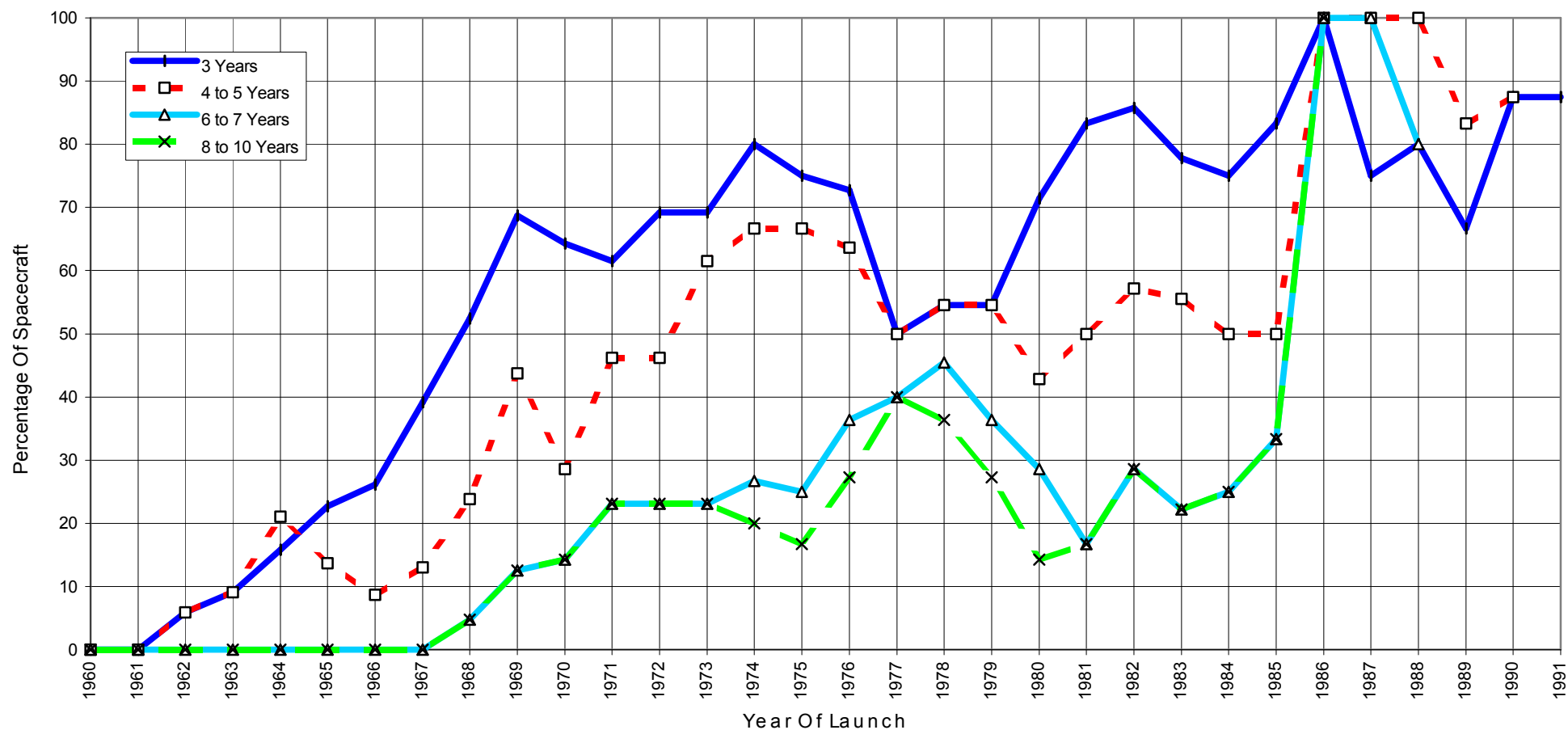


Figure 8. Success Rate For Achieving x Years Of Useful Life On-Orbit For GSFC Spacecraft  
(Three Year Moving Average Through 1994)



APPENDIX I. CLASSIFICATIONS OF 1994 ANOMALIES (excepting SAMPEX)

<u>S/C</u>	<u>Index</u>	<u>AnDate</u>	<u>Subsys</u>	<u>Crit</u>	<u>AnEffect</u>	<u>FailCut</u>	<u>AnType</u>
CGRO	9421	940313	5	1	8	6	4
CGRO	9422	940923	5	1	7	6	4
CGRO	9423	941213	5	1	7	6	4
ERBS	9422	940331	7	2	7	1, 5	4
ERBS	9423	940401	7	2	7	1, 5	4
ERBS	9424	940516	7	2	7	1, 5	4
ERBS	9425	940520	7	2	7	1, 5	4
ERBS	9426	940618	7	2	7	1, 5	4
ERBS	9427	940619	7	2	7	1, 5	4
ERBS	9428	940623	7	2	7	1, 5	4
ERBS	9429	940730	7	2	7	1, 5	4
ERBS	9430	940802	8	1	7	5	4
ERBS	9431	940816	7	2	7	1, 5	4
ERBS	9432	940823	7	1	7	1, 5	4
ERBS	9433	940920	7	2	7	1, 5	4
ERBS	9434	941023	7	2	7	1, 5	4
ERBS	9435	941110	7	2	7	1, 5	4
ERBS	9436	941114	7	2	7	1, 5	4
ERBS	9437	941117	7	2	7	1, 5	4
ERBS	9438	941217	7	1	7	1, 5	4
EUVE	9402	940402	5	1	2	1	2
EUVE	9403	940626	5	1	6	6	4
EUVE	9404	940716	8	5	2	6	4
EUVE	9405	940911	5	2	4	6	2
EUVE	9406	941231	5	2	2	6	4
GOES-8	9401	940413	8	2	6	6	1
GOES-8	9402	940414	3	1	9	5	6
GOES-8	9403	940416	1	1	7	6	4
GOES-8	9404	940419	1	1	9	4	6
GOES-8	9405	940422	1	1	1	6	4
GOES-8	9406	940423	1	1	9	4	6
GOES-8	9407	940428	8	1	9	4	1
GOES-8	9408	940501	5	1	9	5	1
GOES-8	9409	940502	1	2	9	5	1
GOES-8	9410	940506	8	1	9	5	6
GOES-8	9411	940508	1	1	7	6	4
GOES-8	9412	940509	8	1	9	1	1
GOES-8	9413	940511	8	2	6	1	1
GOES-8	9414	940511	5	1	6	1	1
GOES-8	9415	940516	2	1	6	1	1

APPENDIX I. CLASSIFICATIONS OF 1994 ANOMALIES (excepting SAMPEX)

<u>S/C</u>	<u>Index</u>	<u>AnDate</u>	<u>Subsys</u>	<u>Crit</u>	<u>AnEffect</u>	<u>FailCut</u>	<u>AnType</u>
GOES-8	9416	940518	2	1	9	5	1
GOES-8	9417	940520	7	1	7	6	4
GOES-8	9418	940523	1	1	7	6	4
GOES-8	9419	940525	7	1	2	5	6
GOES-8	9420	940526	1	1	9	1	1
GOES-8	9421	940527	8	1	6	1	1
GOES-8	9422	940530	6	1	9	4	6
GOES-8	9423	940531	8	2	9	6	4
GOES-8	9424	940601	8	1	7	1	4
GOES-8	9425	940602	1	1	9	6	4
GOES-8	9426	940604	8	1	9	1	1
GOES-8	9427	940606	8	1	7	6	4
GOES-8	9428	940608	7	1	9	6	4
GOES-8	9429	940608	8	1	9	6	4
GOES-8	9430	940609	8	2	7	1	1
GOES-8	9431	940614	1	1	6	1	1
GOES-8	9432	940617	8	1	9	1	6
GOES-8	9433	940620	1	1	7	5	4
GOES-8	9434	940621	1	2	6	1	6
GOES-8	9435	940710	8	1	9	5	1
GOES-8	9436	940716	2	1	9	1	6
GOES-8	9437	940717	8	1	6	6	5
GOES-8	9438	940718	8	2	9	1	6
GOES-8	9439	940724	7	1	9	5	6
GOES-8	9440	940729	8	1	7	1	4
GOES-8	9441	940729	8	1	6	1	1
GOES-8	9442	940730	8	1	7	6	4
GOES-8	9443	940730	8	1	7	6	4
GOES-8	9444	940816	1	2	6	1	6
GOES-8	9445	940817	1	1	8	2	1
GOES-8	9446	940817	1	1	9	1	1
GOES-8	9447	940817	1	2	6	2	6
GOES-8	9448	940817	1	1	9	1	4
GOES-8	9449	940818	2	1	9	5	2
GOES-8	9450	940820	8	1	9	5	6
GOES-8	9451	940824	8	1	6	1	1
GOES-8	9452	940902	1	1	9	5	5
GOES-8	9453	940906	1	2	6	6	1
GOES-8	9454	940914	8	2	6	1	2
GOES-8	9455	940915	2	2	6	6	2

APPENDIX I. CLASSIFICATIONS OF 1994 ANOMALIES (excepting SAMPEX)

<u>S/C</u>	<u>Index</u>	<u>AnDate</u>	<u>Subsys</u>	<u>Crit</u>	<u>AnEffect</u>	<u>FailCut</u>	<u>AnType</u>
GOES-8	9456	940919	1	2	7	6	2
GOES-8	9457	940920	8	2	6	1	1
GOES-8	9458	941011	8	2	6	3	2
GOES-8	9459	941019	9	1	9	5	4
GOES-8	9460	941021	8	1	9	1	1
GOES-8	9461	941021	8	1	9	1	1
GOES-8	9462	941021	8	1	9	4	1
GOES-8	9463	941101	2	1	9	1	6
GOES-8	9464	941115	9	1	9	6	5
GOES-8	9465	941201	1	2	6	1	1
GOES-8	9466	941214	8	2	6	6	4
HST	9474	940224	8	1	7	6	4
HST	9475	940329	2	2	4	1, 2	2
HST	9476	940411	2	1	7	4	2
HST	9477	940420	5	1	7	6	4
HST	9478	940525	8	1	6	6	4
HST	9479	940615	1	1	7	6	4
HST	9480	940705	7	1	4	6	4
HST	9481	940705	7	1	4	1	2
HST	9482	940707	7	1	6	1	5
HST	9483	940722	5	1	6	6	2
HST	9484	940803	7	1	6	6	2
HST	9485	940810	5	1	6	5	2
HST	9486	940823	1	2	6	6	2
HST	9487	940904	2	1	6	6	2
HST	9488	941024	8	1	6	6	2
HST	9489	941031	8	1	6	6	4
HST	9490	941207	1	2	8	6	4
HST	9491	941212	1	1	8	3	4
HST	9492	941223	5	1	9	6	4
IUE	9433	940127	7	1	9	6	4
IUE	9434	940201	7	1	7	6	4
IUE	9435	940314	7	1	9	6	4
IUE	9436	940325	7	1	7	6	4
IUE	9437	940326	7	1	7	6	4
IUE	9438	940704	7	1	9	6	4
IUE	9439	940709	7	1	7	6	4
IUE	9440	940724	7	1	7	6	4
IUE	9441	940725	7	1	9	6	4
IUE	9442	940726	7	1	9	6	4

APPENDIX I. CLASSIFICATIONS OF 1994 ANOMALIES (excepting SAMPEX)

<u>S/C</u>	<u>Index</u>	<u>AnDate</u>	<u>Subsys</u>	<u>Crit</u>	<u>AnEffect</u>	<u>FailCut</u>	<u>AnType</u>
IUE	9443	940731	7	1	9	6	4
IUE	9444	941004	1	1	9	6	4
IUE	9445	941122	5	2	6	6	4
NIMBUS-7	9475	940411	7	5	1	6	4
NOAA-09	9434	940805	1	2	2	6	4
NOAA-11	9426	940913	2	2	6	3	4
NOAA-11	9427	941003	8	0	2	6	4
NOAA-11	9428	941016	8	2	7	6	4
NOAA-12	9416	940419	1	1	6	5	1
NOAA-12	9417	940419	1	2	6	6	1
NOAA-12	9418	940601	5	2	6	6	4
NOAA-14	9401	941230	1	2	6	6	4
NOAA-14	9402	941230	1	2	6	6	4
SPARTAN 201-02	9401		8	4	2	1	1
TDRS-1	9471	940101	9	1	9	5	1
TDRS-3	9419	940224	7	1	6	6	4
TDRS-4	9429	940301	7	1	6	6	4
TDRS-4	9430	940408	5	1	6	6	1
TDRS-5	9411	940528	5	2	8	6	3
TDRS-5	9412	940529	8	2	8	3	4
TDRS-6	9407	940604	1	1	9	4	2
TOMS	9401	941223	8	5	2	6	4
UARS	9411	940106	5	2	6	6	4
UARS	9412	940119	8	1	9	6	4
UARS	9413	940226	2	1	6	5	1
UARS	9414	940228	9	1	7	5	1
UARS	9415	940305	5	2	8	6	4
UARS	9416	940315	7	1	9	6	4
UARS	9417	940907	1	1	7	6	4
WIND (GGS)	9401	941101	3	1	8	6	2
WIND (GGS)	9402	941107	6	1	6	1	1
WIND (GGS)	9403	941117	8	1	6	1	2
WIND (GGS)	9404	941129	8	1	9	2	1
WIND (GGS)	9405	941201	7	1	9	1	1
WIND (GGS)	9406	941205	8	1	9	6	4

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CGRO	9421	940313 1074	5	1	Apparent failure of internal circuit affecting analog & bilevel telemetry	RIU-B turned off; RIU-A turned on; telemetry normal	SOAR (no number)
CGRO	9422	940923 1268	5	1	Missing COMPTEL Actual Time Commands	No common relationship between occurrences discovered	GRO OAS,dtd. 950212
CGRO	9423	941213 1348	5	1	Missing COMPTEL Actual Time Commands		GRO OAS,dtd. 950212
ERBS	9422	940331 3465	7	2	CSM #1 block memory location failed (445)		EAR501
ERBS	9423	940401 3466	7	2	CSM #1 block memory location failed	Time field changed in each location 424, 435)	EAR502
ERBS	9424	940516 3511	7	2	CSM #1 block memory location failed (437)	Uplinked BLK4	EAR503
ERBS	9425	940520 3515	7	2	One block memory failed validity		EAR504
ERBS	9426	940618 3544	7	2	CSM block memory failed on C1 dump	Uplink Block 4 C1 dump; failed	EAR505
ERBS	9427	940619 3545	7	2	CSM1 block mem. 2 locations failed validity check		EAR506
ERBS	9428	940623 3549	7	2	CSM1 block memory failed	Uplinked Blk4 and redumped successfully	EAR507

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ERBS	9429	940730 3586	7	2	7 locations in CSM1 memory failed	Two events lost/Offline investigation to be performed to determine impact to SAGE events	EAR508
ERBS	9430	940802 3589	8	1	High azimuth motor currents	Missed SR event entirely/Offline investigation to be performed	EAR509
ERBS	9431	940816 3603	7	2	Location 445 failed on C1 dump	Load Block 4	EAR510
ERBS	9432	940823 3610	7	1	1 location failed validity check in CSM1 memory	Sent cmd to correct any possible error at this location	EAR511
ERBS	9433	940920 3638	7	2	Locations 429 & 440 failed in CSM1 memory	Uplinked BLK4 & redumped CSM1 successfully.	EAR512
ERBS	9434	941023 3671	7	2	7 locations failed validity check in CSM1 memory	Possible loss of 1 SAGE event/Uplinked LD296-A1 to correct affected locations	EAR513
ERBS	9435	941110 3689	7	2	1 location (445) failed validity check	Uplinked BLK4	EAR514
ERBS	9436	941114 3693	7	2	Location 271 failed validity check	Sent CSM cmd to correct location #271	EAR515
ERBS	9437	941117 3696	7	2	Location 274 412 failed in block mem. CSM1 dump	Uplinked BLK4 and ZERO9 load	EAR516
ERBS	9438	941217 3726	7	1	Memory hit; location 271 failed validity check	Uplinked ZERO9 successfully	EAR517

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EUVE	9402	940402 664	5	1	Transponder B failed with 4414 hrs. usage	Final power amp not working/Switched TLM&DH to transponder A	SOAR B-0224, C-73
EUVE	9403	940626 750	5	1	Data gap - recorder did not record over positions 80-83	Lost data/Fix to stop recorder automatically under development	SOAR B-0225
EUVE	9404	940716 770	8	5	Major fcns of EVEEP exper. failed to provide data; PED module curr. incr'd to 1.6 A (fm 0.8), settled to below 0.6 A. Appar. fail. of 15 V dc/dc conv.	Total instrument failure; mission objectives met before failure	SOAR B-0277
EUVE	9405	940911 827	5	2	Tape position sensor failed; high servo errors	Will attempt to fail over to redundant capstan tachometer sensor	SOAR B-0276
EUVE	9406	941231 938	5	2	Tape recorder failure; no tape motion observed	Will attempt to move tape through forward playback mode; attempt to restore tape motion	SOAR
GOES-8	9401	940413 1	8	2	Excessive noise level		GIR IOPS-096
GOES-8	9402	940414 1	3	1	High temp indication on valve/engine flange temp.; software design problem; reprogrammed	Apogee motor fire aborted/Software design problem; reprogrammed	GW, GIR IACT-028
GOES-8	9403	940416 4	1	1	Pass transistor changed temp greater than 3 deg.		GIR IACT-180
GOES-8	9404	940419 6	1	1	Sun presence bit went high & latched ES	Caused by radiation belt environment in transfer orbit; longer than expected. No C. A. req'd.	GIR IACT-022
GOES-8	9405	940422 9	1	1	Spurious thruster firings in response to single frame spurious gyro data	Swapped AOCE's; not a problem in final orbit	GIR IACT-021

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GOES-8	9406	940423 10	1	1	Sun presence bit went high & latched ES	Caused by radiation belt environment in transfer orbit; longer than expected	GIR IACT-027
GOES-8	9407	940428 15	8	1	Z-axis drifted to + saturation & remained there	Chnage procedure to turn on only above -40 deg.	GIR IACT-048
GOES-8	9408	940501 18	5	1	AOCE data not available except during on-orbit	No AOCE data available during station keeping; not req'd at this time	GIR IACT-049
GOES-8	9409	940502 19	1	2	SAS does not indicate correct sun angle	Incorrect telemetry conversion data; corrected data supplied	GIR IACT-052
GOES-8	9410	940506 23	8	1	Scan Mirror Contam. Avoid. script performed out of sequence; caused over-temps of scan mirrors and other components	No damage to instruments; change in operational procedure made	GIR IACT-113
GOES-8	9411	940508 26	1	1	Reflected sunlight corrupted SLTESR data		GIR IACT-134
GOES-8	9412	940509 27	8	1	False stars seen in imagery; impulse noise from space environment	Continue to monitor for impulse noise	GIR IACT-079
GOES-8	9413	940511 29	8	2	Magnetometer magnetic moments higher than expected	None noted/Local magnetic sources on magnetometer; future designs to be revised	GIR IACT-096
GOES-8	9414	940516 29	5	1	Excessive noise in torquer coil 1 & 2 telemetry		GIR IACT-097
GOES-8	9415	940516 34	2	1	Battery charge lost to S/C buss when battery voltage exceeded 42V		GIR IACT-208



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GOES-8	9416	940518 36	2	1	Sun pointing deviates from normal; caused by orbit eccentricity	Reduced orbit eccentricity, reduced pointing errors to acceptable limit	GIR IACT-119
GOES-8	9417	940520 38	7	1	Commands to Imager not being executed	Commands continued in clear mode; investigate with NOAA ground commanding system	GW
GOES-8	9418	940523	1	1	Magn. torquer currents not constant; telemetered currents, spikes, beat frequencies and oscillations		GIR IACT-151
GOES-8	9419	940525 43	7	1	Cmd unit #2 bit flip	Occurred during GND station hand-over activities/SOH to be revised	GIR IACT-146
GOES-8	9420	940526 44	1	1	During ES mode switch large negative error in control loop	Correct SOH	GIR IACT-148
GOES-8	9421	940527 45	8	1	Filter wheel motor temp. higher than design limit	Operational instructions amended to require w/outgas heater on; predict no mission life jeopardy	GIR IACT-194
GOES-8	9422	940530 48	6	1	Higher than expected SAS temp	Limit revised, by waiver	GIR IACT-152
GOES-8	9423	940531 49	8	2	Imager response low		GIR IACT-157
GOES-8	9424	940601 50	8	1	Glint into earth sensors at S/C midnight	Operational workarounds to be developed	GW
GOES-8	9425	940602 51	1	1	Momentum wheel current spike		GIR IACT-158

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GOES-8	9426	940604 53	8	1	Sounder filter wheel cooler at higher temp. than norm	Solar loading higher than predicted during summer; no C. A. recommended - impact deemed negligible	GIR IACT-186
GOES-8	9427	940606 55	8	1	Assymetry between East and West "looks"	Unknown	GIR IACT-187
GOES-8	9428	940608 57	7	1	Momentum wheel current spikes detected	Being investigated	GW
GOES-8	9429	940608 57	8	1	Noise in Imager	Interferences sources NOT in S/C	GW
GOES-8	9430	940609 58	8	2	Thermistors do not read correct mirror temps. at certain times	Scan mirror emissivity calibration data corrected	GIR ISPOT-249
GOES-8	9431	940614 63	1	1	ES pitch error when roll/pitch magn. torquer makes current transition	HZC algorithm patch	GIR ISPOT-029
GOES-8	9432	940617 66	8	1	Toggling behavior of Sounder filter wheel Ch 1 Period Monitor	Noise problem; instrument degradation	GIR ISPOT-021
GOES-8	9433	940620	1	1	ES single chord pointing variation	S/W modification will improve single chord trending	GIR IACT-205
GOES-8	9434	940621 70	1	2	Roll Magn. Torquer motor saturates	None significant; SOH revised	GIR ISPOT-001
GOES-8	9435	940710 89	8	1	Imager locked up, when GND SYS transmitted cmds out of order	Returned to normal operation/GND SYS problem	GW

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GOES-8	9436	940716 85	2	1	Potentiometer exhibiting dropouts in saturated range	SOH correction	GIR ISPOT-071
GOES-8	9437	940717 96	8	1	Imager pointer errors over diurnal period	Intermittent pointing errors up to 8km	GW
GOES-8	9438	940718 87	8	2	Cmd registers being sent invalid commands		GIR ISPOT-089
GOES-8	9439	940724 103	7	1	MOST misunderstood operational parameters of CASS-AOCE interface	SOH revised	GIR JETE-1-006
GOES-8	9440	940729 108	8	1	Nonlinearities in ECAL output		GIR ISPOT-252
GOES-8	9441	940729 108	8	1	ECAL anomaly	Caused by noise coupling into detector wiring	GIR ISPOT-252
GOES-8	9442	940730	8	1	Data quantizer shows irregularities in histogram bins		GIR ISPOT-250
GOES-8	9443	940730	8	1	Imager data quantizers show irregularities		GIR ISPOT-251
GOES-8	9444	940816 126	1	2	Pitch momentum unloads cause roll/yaw interaction, affecting star residuals		GIR IOPS-087
GOES-8	9445	940817 127	1	1	SMC PathC Enable failure	S/W revised	GIR ISPOT-115

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GOES-8	9446	940817 127	1	1	Transient on SHM compensation signal		GIR ISPOT-136
GOES-8	9447	940817 127	1	2	Magn. torquer not shed during safe hold #1	SOH incomplete	GIR ISPOT-159
GOES-8	9448	940817 127	1	1	S/C loss of lock caused safe hold	SMC S/W patch may be cause	GW
GOES-8	9449	940818 128	2	1	Sequencer timing anomaly	Early switch in final flip-flop of sequencer timing chain	GIR IOPS-012
GOES-8	9450	940820 130	8	1	MOL protection enable for high motor current	Ground system error - cmd'd scan outside of permissible field of view; S/C operated properly	GW
GOES-8	9451	940824 134	8	1	Solar intrusions caused thermal spikes	Revised operational procedures	GIR ISPOT-154
GOES-8	9452	940902 143	1	1	AOCE #1 performance margin lower	Caused by wiring error/Manufacturing error	GW
GOES-8	9453	940906 150	1	2	Unexpected errors & anomalous spikes		GIR ISPOT-176
GOES-8	9454	940914 155	8	2	Response fell in Ch's 9, 15, 16, 17		GIR ISPOT-168
GOES-8	9455	940915 156	2	2	SADA/A potentiometer spiked		GIR ISPOT-178

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GOES-8	9456	940919 160	1	2	Sudden pointing errors & large pitch disturbance		GIR ISPOT- 192
GOES-8	9457	940920 161	8	2	Sounder E/W servo errors	Probable cause; loss of redundancy in motor wiring circuitry	GIR ISPOT- 182
GOES-8	9458	941011 182	8	2	Scan motor current increasing over past months	Suspected failed motor winding	FAMW
GOES-8	9459	941019	9	1	Reprogram patches should be followed by firmware document update		GIR ISPOT- 243
GOES-8	9460	941021 192	8	1	Baseplate temp falls below 10 deg. daily	Heater current shows saturation	GIR ISPOT- 239
GOES-8	9461	941021 192	8	1	Base plate temp. falls below limit daily	Heater currents show saturation	GIR ISPOT- 240
GOES-8	9462	941021 192	8	1	Cooler housing, louver, electronics and primary mirror temp. violations	SHM (safe hold mode) operations script revised (S/W)	GIR ISPOT- 241
GOES-8	9463	941101 203	2	1	Autoload turn-on delay	SOH error	GIR IOPS-003
GOES-8	9464	941115	9	1	Pointing errors of 150 urads; occurs daily at 2019Z	Attributed to ES data error	GIR IOPS-026
GOES-8	9465	941201 233	1	2	Solar array slew caused high star residuals following trim tab adjustments	SOH revised	GIR IOPS-045

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GOES-8	9466	941214 246	8	2	Solar xray flux values higher than expected; lower reproductibility than expected		GIR IOPS-133
HST	9474	940224 1403	8	1	GHRS carousel failed to lock; 2 of 11 observations missing	Investigated; no subsequent anomalies noted	GW
HST	9475	940329 1436	2	2	Solar panel assy lost; shorted; decreased power to battery 5	Less system power capacity; projected impact on science missions is March 2000, if not replaced by then. Shorted SPA bypassed	Proj. #075, SOAR C-113
HST	9476	940411 1449	2	1	During SADE1 slew, SAP test failed, S/C into SAFEMODE	Recovered gtom SAFEMODE/Probable SEU hit	P #076, HST-4724, SOAR C-114
HST	9477	940420 1458	5	1	Ku bent pipe telemetry problems	Unknown	GW
HST	9478	940525 1493	8	1	1 of 4 images saturated	Lost piece of science data	GW
HST	9479	940615 1514	1	1	FGS motor encoder temp's continually above heater set point	Unknown	GW
HST	9480	940705 1534	7	1	Command from computer failed; computer executing commands erratically	Operations placed on manual SAFEMODE/ To FRB	P #077, HST-4832, SOAR C-115
HST	9481	940705 1534	7	1	No parity error indication for #9407 anomaly	Parity not detected when used as LMU#3	P #079, SOAR C-117
HST	9482	940707 1536	7	1	Memory counters overflowed 2.5 days & disrupted normal gyro data flow	Flight S/W cannot handle extended gyro low mode data flow/Flight S/W to be corrected	P #078, SOAR C-116

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HST	9483	940722 1551	5	1	Five bit flips per event in engineering tape	Solar arrays not commanded & no SAFING occurred. Incident to FRB	P #080, HST-4325, SOAR C-118
HST	9484	940803 1563	7	1	Command overlap into science data readout; WF/PC-2 SDF interface hung	Lost 6 WF/PC-2 obsvns/Real time command intervention	GW
HST	9485	940810 1570	5	1	Lost 1 WF/PC-2 picture when tape recorder changed tracks while observation was being written to tape	Lost picture	GW
HST	9486	940823 1583	1	2	Lost coarse track and fine lock during star guide acquisition	Loss of lock/Check compensated voltages on all FGS servos	P #081, SOAR C-119
HST	9487	940904 1595	2	1	Safemode counter contained 1-3 error counts after solar array slews	Five error counts would cause SAFEMODE	P #082, SOAR C-120
HST	9488	941024 1645	8	1	FOS instrument SAFED after 18 speed check errors; implies processor too busy. Reset		P #083, HST-4965, SOAR C-121
HST	9489	941031 1652	8	1	FOS safed itself; possible transient which corrupted FOS microprocessor	Lost 5 days science operations	GW
HST	9490	941207 1689	1	2	Gyro 5 motor current excessive	Gyro 5 current to be monitored and shut down if it exceeds 240 mA	P #084, SOAR C-122
HST	9491	941212 1694	1	1	Gyro 5 motor current out of range	Lube patch problem	GW
HST	9492	941223 1705	5	1	Tape recorder failed to come up to speed	Lost science data/Tape recorders assigned	P #085, HST-5063, SOAR C-123

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IUE	9433	940127 5845	7	1	Datablock uplinked & rcv'd, but not transferred correctly into OBC memory	Has occurred before; no C.A.; relinked and processed correctly	SCAR V-057
IUE	9434	940201 5850	7	1	C'md sent and rcv'd but did not take	Re-uplinked and processed correctly	SCAR V-058
IUE	9435	940314 5891	7	1	OBC cut camera exposure short; has occurred in past	No C.A. taken	SCAR G-198
IUE	9436	940325 5902	7	1	Cmd set & rcv'd but did not take	Re-uplinked & processed correctly; no C.A.	SCAR G-199
IUE	9437	940326 5903	7	1	Cmd not executed properly	Uplinked again & executed successfully	SCAR G-200
IUE	9438	940704 5903	7	1	Cmd to FES #2 uplinked but did not take	Uplinked again & processed correctly	SCAR V-059
IUE	9439	940709 6008	7	1	Datablock uplinked and not transferred correctly	Re-uplinked & processed correctly	SCAR V-060
IUE	9440	940724 6023	7	1	Datablock uplinked and not transferred correctly	Re-uplinked & processed correctly	SCAR G-201
IUE	9441	940725 6024	7	1	Datablock uplinked but not transferred correctly	Re-uplinked & processed correctly	SCAR G-202
IUE	9442	940726 6025	7	1	Datablock uplinked but not transferred properly	Re-uplinked and executed properly	SCAR G-203



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IUE	9443	940731 6030	7	1	Datablock uplinked but not transferred correctly	Re-uplinked and processed correctly	SCAR G-204
IUE	9444	941004 6095	1	1	S/C pitch and yaw varied; Gyro drift measured	New gyro trims uplinked; S/C stable next day	SCAR V-061
IUE	9445	941122 6143	5	2	Pitch reaction wheel changed without s/c attitude change	TLM corruption cleared by switching DMU to FMT 2	SCAR G-205
NIMBUS-7	9475	940411 5649	7	5	SANTIAGO GS unable to acquire S/C; 4 attempts	Loss of S/C mission	OSP/A ARF, dtd 940414
NOAA-09	9434	940805 3527	1	2	Reaction wheel (Z) failed after large pitch attitude transient	Wheel operating nominally until failure; attempts to restart wheel failed	TOAR-335, SOAR C-8
NOAA-11	9426	940913 2187	2	2	Motor current increased; previous AVHRR anomalies noted	Series of tests run but anomaly not corrected	TOAR-336, SOAR C-9
NOAA-11	9427	941003 2207	8	0	Drive transistors overheating	Instrument malfunctions; attempts to cool down transistors being done	FAMW
NOAA-11	9428	941016 2220	8	2	Diffuser not in stow position	Unknown	TOAR-337, SOAR C-15
NOAA-12	9416	940419 1072	1	1	Skew gyro rate output instability	Running self test improves gyro rate stability	TOAR-333
NOAA-12	9417	940419 1072	1	2	Gyro rate output instability	Erroneous telemetry information due to database problem; gyro self tests performed to reduce drift rate	TOAR-333, SOAR C-6

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NOAA-12	9418	940601 1115	5	2	Microwave Sounding Unit encoder gray codes fixed at 192	Under investigation	TOAR- 334, SOAR C-7
NOAA-14	9401	941230 1	1	2	Regulator leak caused attitude disturbance	Loss of earth lock; leak continued until high and low pressure N2 stabilized at 540 psi	TOAR- 338, SOAR C- 14
NOAA-14	9402	941230 1	1	2	GN2 relief valve opened to relieve press in LP sys and un-neutralized thrust vent resulted	Un-neutralized throust vent	TOAR- 339, SOAR C- 13
SPARTAN 201-02	9401		8	4	WLC solar images saturated, instrument failed	External occulting disk oversized; original- sized disk will be fitted for next flight	Proj memo 741/ SP20 1-EN-9
TDRS-1	9471	940101 3926	9	1	Incorrect year time tag's on GS antenna pointing vectors	Caused multiple ETO's	GW
TDRS-3	9419	940224 3980	7	1	Cmd word has invalid value	Reset and verify integrity	TSOAR 159-G
TDRS-4	9429	940301 3985	7	1	Cmd Processor B decoder address changed to incorrect value	Reset and verify integrity	TSOAR 159-G
TDRS-4	9430	940408 4023	5	1	TWTA 465 helix currents high; TLM signal dropped 10 dB	Reset all PDA's to nominal - anomaly resolved	TSOAR 160-4
TDRS-5	9411	940528 4073	5	2	SSA1E TWTA failed	Switched to redundant SSA2E	TSOAR 161-5
TDRS-5	9412	940529 4074	8	2	Sband primary TWTA failed	SSAF service returned by using redundant TWTA	GW

APPENDIX II. Log of 1994 Anomalies (excepting SAMPEX)

<u>S/C</u>	<u>INDEX</u>	<u>ANDATE</u> <u>#days</u>	<u>SYS</u>	<u>CRIT</u>	<u>DESCRIPTION</u>	<u>EFFECT/ACTION</u>	<u>REF</u>
TDRS-6	9407	940604 4080	1	1	Control Processor initialized itself, causing attitude divergence	CPE reinitialized from GND STA; anomaly caused by ESD in thermal blanket	TSOAR 162-6
TOMS	9401	941223 357	8	5	Instrument chopper motor current dropped to zero; current spikes; no chopper motor rotation during these periods	Unknown	SOAR/no number
UARS	9411	940106 848	5	2	Noise in TR-A	Some data loss; overlap with TR-B used to fix	GW, AR 94-005
UARS	9412	940119 861	8	1	MLS scan system anomalies, intermittent response to cmd'd position changes	Some loss of atmospheric data	GW, AR 94-015
UARS	9413	940226 900	2	1	Low volt/low charge battery; caused by large S/C load during maximum beta angle	Load shed; instruments returned to normal in 24 hrs.	GW
UARS	9414	940228 902	9	1	Corrupted files in disk pack; caused operational halt, loss of command capability	Failures of both primary and secondary disk packs	GW
UARS	9415	940305 907	5	2	After diminishing, noise in TR-A returned; TR-B only will be used for science data	Loss of TR redundancy	GW
UARS	9416	940315 917	7	1	Yaw cmd's not executed, caused drop in bus voltage and load shed	All instruments turned off except two; yaw maneuver rescheduled for next day	GW
UARS	9417	940907 1092	1	1	Large filler residuals in Tape Recorder playback	SSPP pointing affected	AR 94-196
Wind (GGS)	9401	941101 1	3	1	REA #10 performed at 75% of expected thrust	2.5 deg. S/C precession; flush attempted; unsuccessful	SOAR C- 72, PR501

APPENDIX II. Log of 1994 Anomalies (excepting SAMPEX)

<u>S/C</u>	<u>INDEX</u>	<u>ANDATE</u> <u>#days</u>	<u>SYS</u>	<u>CRIT</u>	<u>DESCRIPTION</u>	<u>EFFECT/ACTION</u>	<u>REF</u>
Wind (GGS)	9402	941107 7	6	1	Valve cooling anomalous; remained at high temp for over 1 hr. then cooled rapidly	Design problem with op- amp latch up	PR564
Wind (GGS)	9403	941117 17	8	1	SWE Instrument shut down because of current overshoot	Unexpected counter advance	SOAR (no #), PR618
Wind (GGS)	9404	941129 29	8	1	SWE reset in emergency turn-off; cause - extraneous cmd in SCT	Instrument returned to full operation	SOAR C-
Wind (GGS)	9405	941201 30	7	1	S/W interprets SCT cmd times as being late when S/C clock is before rollover	Ground procedure must be changed	SOAR (no #), PR657
Wind (GGS)	9405	941205 35	8	1	Cmds up-link caused TGRS reset & loss of patches in RAM	Reinitialized and patch reinstalled	SOAR C-5

### APPENDIX III. Log of 1994 SAMPEX Anomalies

<u>INDEX</u>	<u>ADATE</u>	<u>SYS</u>	<u>DESCRIPTION</u>	<u>EFFECT/ACTION</u>	<u>REF</u>
94143	940118	5	Error in closing data set	Manually freed & closed; dumped; improvement suggested to mgmt	S-143
94144	940206	1	Torque rod X current flagged yellow twice	None/Previously reported (S-062)	S-144
94145	940208	5	S/C clock drifted	Unable to adjust clock before LOS	S-145
94146	940209	2	VC1 playback indicated RPP current flagged YH; returned to limits	RPP current had gone OOL 90 sec prior to TXP turn off	S-146
94147	940209	5	Anomalous ISR request received	S/W error; occurred as in S-099	S-147
94148	940209	8	Monitor 15 & 16 OOL	Known anomaly—No further resolu needed	S-148
04149	940211	5	Unusual event msg in Sig Events dump	Never seen before; S/C health appears OK	S-149
94150	940216	8	LEICA HV monitor tripped & returned to normal	Known anomaly/LEICA normal	S-150
94151	940220	8	Events page snaps	Ran recovery procedure. Recovery nominal	S-151
94152	940221	8	Monitor IDs 15 & 16 changed threshold	Known anomaly	S-152
94153	940221	1	Torque-rod currents OOL during VC1 playback	Previously reported (S-062)	S-153
94154	940223	8	HILT Drift HV did not come up to nominal value right away	On next pass, Drift HV to nominal	S-154
94155	940224	1	DDS error OOL for 25 sec	Normal DSS errors due to increased actuation during eclipse or coast	S-155
94156	940225	8	Monitor 15 HV changed threshold, returned to normal	Known anomaly	S-156
94157	940302	7	DPU clock error detected	Known anomaly	S-157
94158	940305	6	MAST baseplate temp. YH-high	Known anomaly—S/C in full sun season	S-158
94159	940305	8	LVPS +7.5 V monitor OOL	Known anomaly—charac. Of full sun season	S-159
94160	940306	6	Base plate temp. OOL	Known anomaly—full sun season	S-160
94161	940306	1	X and Y Torque rods OOL	Previously reported (S-062)	S-161
94162	940308	5	Clock error noted	Gnd stn in clock adjust commands	S-162
94163	940315	7	MAST event quota flagged YH	Normal when instruments were off, which they were	S-163
94164	940321	8	HILT watchdog error count		S-164
94165	940322	8	MAST event quota flagged YH	Normal when MAST off	S-165
94166	940323	5	SNSCECT incremented		S-166

### APPENDIX III. Log of 1994 SAMPEX Anomalies

<u>INDEX</u>	<u>ADATE</u>	<u>SYS</u>	<u>DESCRIPTION</u>	<u>EFFECT/ACTION</u>	<u>REF</u>
94167	940324	8	HILT power cycle anomaly		S-167
94168	940329	7	DMASTREQ out of time	Normal—when instrument off	S-168
94169	940330	2	Battery bracket temp. monitor flagged	Charac. of full sun season	S-169
94170	940403	8	LEICA HV monitor 15 & 16 OOL	Known anomaly	S-171
94171	940404	8	HV monitor 15 & 16 into threshold zero	Known anomaly	S-172
94172	940404	8	Monitors 15 & 16 to threshold zero	Known anomaly	S-174
94173	940405	8	Monitors 15 & 16 to threshold zero	Known anomaly	S-175
94174	940405	8	Monitors 15 & 16 to threshold zero; emerg. seqs executed	Known anomaly	S-176
94175	940406	8	Mnemonics & monitor IDs 15 & 16 flagged	Known anomaly	S-177
94176	940407	8	Monitor IDs 15 & 16 remained in threshold zero for 3 updates	Known anomaly. Caused emergency sequence; instrument successfully recovered	S-178
94177	940407	8	Monitor IDs 15 & 16 remained in threshold zero for 3 updates	Known anomaly	S-179
94178	940412	5	S/C event msg anomalous ISR request rcv'd	Known anomaly—S-099 & -147	S-180
94179	940417	6	VC1 playback batt bracket temp to YL 7 times	Previously reported—S-083	S-181
94180	940417	8	Battery bracket temp. monitor flagged YL; returned to limits within 2.5 min.	Previously reported—S-083	S-182
94181	940421	5	CTT current monitor flagged YH and returned	Previously reported—S-096	S-184
94182	940422	1	Essential bus current spiked to to 2.5 A, returned to 2.07 A	Probably caused by reaction wheel actuation	S-185
94183	940424	5	SCECT incremented to 4 from 1	Caused by ground station error; not seeing downlink	S-186
94184	940426	1	ADENSITY flagged YH	Caused by unexpected low atmos density & low solar activity	S-187
94185	940428	5	Internal error	Previously reported S-149	S-188
94186	940502	8	Monitor IDs 15 & 16 at threshold zero	Known anomaly	S-189
94187	940504	5	Memory dump in program; monitor ID22 failed to detect	Dataset event nonrecoverable; timing problem	S-190
94188	940504	8	Monitor ID 15 & 16 at threshold zero	Known anomaly	S-191
94189	940506	8	Monitor ID 15 & 16 at threshold zero	Known anomaly	S-192
94190	940508	5	Degraded data & dropout	Caused by antenna null	S-194

### APPENDIX III. Log of 1994 SAMPEX Anomalies

<u>INDEX</u>	<u>ADATE</u>	<u>SYS</u>	<u>DESCRIPTION</u>	<u>EFFECT/ACTION</u>	<u>REF</u>
94191	940509	8	Monitor ID 15 & 16 at threshold zero	Known anomaly	S-195
94192	940509	8	Monitor ID 15 & 16 at threshold zero	Known anomaly	S-196
94193	940509	8	Monitor ID 15 & 16 at threshold zero	Known anomaly	S-197
94194	940510	8	Monitor ID 15 & 16 at threshold zero	Known anomaly	S-198
94195	940510	8	Monitor ID 15 & 16 at threshold zero	Known anomaly	S-199
94196	940511	8	Monitor ID 15 & 16 at threshold zero	Known anomaly	S-200
94196	940513	1	Ephemeris update failed	FDF provided incorrect ephemeris vector	S-201
94197	940526	1	Reaction wheel went RL	Caused by new ACS algorithm implemented; new limits required	S-204
94198	940525	5	DPU MAST running event quota flagged YH		S-203
94199	940526	2	WBATI went YH	Caused by deep eclipse and transmitter power	S-205
94200	940527	1	ATQRXI WENT YH		S-206
94201	940528	5	Telemetry mnemonics OOL during R/T & VC1 playback	Previously reported: S-056, 062, 155, 187	S-207
94202	940528	1	Telemetry OOL during VC1 playback	Previously reported: S-204	S-208
94203	940601	5	RPP warm restart counter had incremented by one; warm had occurred	Ran warm restart recovery program	S-209
94204	940602	8	Start plate conv mon flagged YH, rtn'd to limits within 2 min; occurred again		S-210
94205	940602	1	Mnemonics OOL during VC1 playback		S-211
94206	940603	5	Table 59 dump after RPP warm restart (S-210) showed 5 mis- compares	Cause: patched TO filter table and incorrect S/W	S-212
94207	940605	9	HILT mnemonic drift HV monitor flagged YH and re- turned to normal	Characteristic of full sun season	S-213
94208	940606	6	MAST/PET LVPS monitor OOL	Characteristic of full sun season	S-214
940209	940609	7	LOS configmon flagged mnemonics OOL	Known anomaly	S-215
94210	940609	8	Start plate HV monitor flagged YH & returned to limits; repeated	Previously reported (S-177)	S-216
94211	940612	5	DPU clock error; HILT drift HV monitor OOL; MAST event quota OOL	Known anomalies	S-217
94212	940613	8	Telemetry pts exc'd limits: MAST event quota, MAST LVPS, HILT drift HV	Known anomalies—characteristic of full sun season	S-218
94213	940618	1	ADSSXER OOL YH & returned		S-219

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<u>INDEX</u>	<u>ADATE</u>	<u>SYS</u>	<u>DESCRIPTION</u>	<u>EFFECT/ACTION</u>	<u>REF</u>
94214	940619	1	ADSSXER OOL YH & returned		S-220
94215	940621	8	Two telemetry points flagged OOL	Reset quotas	S-221
94216	940629	8	HILT watchdog error counter flagged RH; instrument cycled back off		S-222
94217	940701	6	Battery bracket temp flagged YL several times	Changed YL limit	S-223
94218	940702	5	MAST event quota exceeded limits		S-224
94219	940702	8	Monitor IDs 15 & 16 tripped, threshold zero	Known anomaly	S-225
94220	940703	1	Mnemonic flagged YL during VC1 playback; repeated limit violations		S-226
94221	940703	1	ATQRYI flagged YL in offline VC1 playback	None during real time; limits changed due to new ACS performance	S-227
94222	940705	8	+37 V monitor flagged YL	Characteristic of full sun season	S-228
94223	940707	8	Monitor IDs 15 & 16 entered threshold zero	Known anomaly	S-229
94224	940707	1	ADSSZER OOL twice		S-230
94225	940708	1	DSS Z error OOL & returned	Changed limits	S-231
94226	940709	1	ADSSZER and ADSSXER OOL	Changed limits	S-232
94227	940711	1	Mnemonics OOL	Changed limits	S-233
94228	940712	1	Reaction wheel interrupt speed flagged YL	Related to wheel speed and accuracy of measurements	S-234
94229	940713	1	ADSSXER OOL YH	Changed limits	S-235
94230	940714	5	Error in close dataset; not able to smd S/C	Error msg expected under conditions existing; no impact on S/C ops	S-236
94231	940714	8	Monitor IDs 15 & 16 tripped	Known anomaly	S-237
94232	940715	8	H&S monitors 15 & 16 failed and safing sequence executed	Known anomaly	S-238
94233	940715	8	Monitors 15 & 16 to threshold zero	Known anomaly	S-239
94234	940716	8	Monitors 15 & 16 failed and instrument safed	Known anomaly	S-240
94235	940717	8	Monitors 15 & 16 failed and instrument safed	Known anomaly	S-242
94236	940719	1	ADSSXER OOL YH	Edited and changed limits	S-242
94237	940719	5	DPU clock error	Known anomaly	S-243
94238	940723	1	ADSSXER OOL YH	Edited to change YH limit	S-244



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<u>INDEX</u>	<u>ADATE</u>	<u>SYS</u>	<u>DESCRIPTION</u>	<u>EFFECT/ACTION</u>	<u>REF</u>
94239	940725	1	Torque rod current flagged YL	Edited to set YL limit	S-246
94240	940725	5	DPU clock error	Known anomaly	S-245
94241	940727	8	Flow regulator valve open	Ran procedure to correct HILT valve cmds; known anomaly	S-247
94242	940731	8	XPWR OFF failed LOS config monitor check	Edited LOS config monitor	S-249
94243	940801	5	Anomalous ISR request received	Previously reported (S-099)	S-250
94244	940802	8	LVPS +37 V monitor flagged YL	Characteristic of full sun season	S-251
94245	940803	1	ATQRXI and ATQRZI OOL YH	Edited procedure to change YH limits	S-252
94246	940804	1	ATQRI OOL YL		S-253
94247	940806	5	DPU clock error	Known anomaly	S-254
94248	940806	1	Pitch error rate OOL during VC1 playback		S-255
94249	940810	5	Warm restart & clock error flag	Freed data set; executed warm recovery successfully	S-256
94250	940813	1	Reaction wheel interrupt speed flagged	Previously reported (S-234)	S-257
94251	940819	1	Torque rod current flagged YH		S-259
94252	940821	8	Monitor IDs 15 & 16 tripped & safing sequence begun	Known anomaly	S-260
94253	940901	1	ATQRZI OOL YH two times	Edited procedure for new YH limit	S-261
94254	940903	8	Drift HV monitor flagged YL	Known anomaly, full sun season	S-262
94255	940903	8	Flow regulator anomaly; HILT drift HV YL & MAST LVPS YH	Known anomalies	S-263
94256	940904	8	LVPS monitor flagged YH two times; returned with 2 minutes	Characteristic of full sun season	S-264
94257	940906	5	DPU clock error	Known anomaly	S-265
94258	940913	5	ESM card msg error counter flagged YH	First occ which orig & retrans msgs did not cross bus; rare but occas expect'd occ.	S-266
94259	940915	8	HILT Drift HV and MAST realloc quota telemetry points OOL	Characteristic of full sun season	S-267
94260	940918	5	MAST event quota exceeded limits		S-268
94261	940927	8	LSTRTCMV made gradual increase to RH		S-269
94262	941003	8	Monitors 15 and 16 tripped to threshold zero three times	Known anomaly	S-270
94263	941003	5	MAST event quota exceeded limits		S-271

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<u>INDEX</u>	<u>ADATE</u>	<u>SYS</u>	<u>DESCRIPTION</u>	<u>EFFECT/ACTION</u>	<u>REF</u>
94264	941005	8	Monitor 15 and 16 tripped four times	Known anomaly	S-272
94265	941005	8	HINITCNT & HXPROFCT flagged	S-273	
94266	941005	2	Battery current monitor OOL YH	Previously reported; caused by deep eclipse coupled with transmit power output	S-274
94267	941006	5	PD/PCU CTT primary current monitor flagged YH and returned to limits	Previously reported; caused by deep eclipse coupled with transmit power output	S-275
94268	941007	1	AINSTAT flag tripped; value of 0, should be 1	Previously reported; occurs when reaction wheel speed is low	S-277
94269	941009	5	DPU clock error detected	Known anomaly	S-277
94270	941010	8	Monitors 15 & 16 tripped to threshold zero	Known anomaly	S-278
94271	941010	2	Battery current flagged to YL for 50 sec.	Caused by deep eclipse coupled with Transmit power output	S-279
94272	941011	1	Pitch error flags		S-280
94273	941011	2	Battery current and cmd and telemetry points OOL & returned	Due to deep eclipse coupled with transmit power output	S-281
94274	941018	2	Current monitor flagged YH	Previously reported (S-275)	S-282
94275	941018	5	PCTTI went YH and returned to limits	Caused by deep eclipse coupled with transmit power output	S-283
94276	941020	5	Science partition full; science data lost (55 min.)	Caused by large amount of science data due to increased solar activity	S-284
94277	941021	5	61 min. science data lost; science partition overflow	Caused by increased solar activity	S-285
94278	941020	5	PCTTI went YH	Previously reported (S-283)	S-286
94279	941022	2	WBATI & PCTTI mnemonics OOL	Previously reported (S-283)	S-287
94280	941023	1	AINSTAT failed config check	Previously reported	S-289
94281	941025	2	WBATI & PCTTI mnemonics OOL	Previously reported (S-283)	S-290
94282	941026	5	Anomalous ISR request received	Previously reported	S-291
94283	941026	2	WBATI & PCTTI mnemonics OOL	Previously reported (S-283)	S-292
94284	941028	1	AINSTAT failed config check	Previously reported	S-293
94285	941030	1	AINSTAT failed config check	Previously reported	S-294
94286	941030	2	PCTTI went YL and returned	Previously reported (S-283)	S-295
94287	941030	1	AINSTAT OOL	Previously reported	S-296
94288	941031	1	ACS partition overflow	Caused by data sets being freed greater than 24 hours apart; 37 min. of data lost	S-297

### APPENDIX III. Log of 1994 SAMPEX Anomalies

<u>INDEX</u>	<u>ADATE</u>	<u>SYS</u>	<u>DESCRIPTION</u>	<u>EFFECT/ACTION</u>	<u>REF</u>
94289	941101	5	ACS partition overflow	Daily load mistakenly built with wrong control partition; ops management problem	S-298
94290	941105	1	AINSTAT failed config monitor check	Previously reported	S-299
94291	941106	8	Monitors 15 and 16 tripped	Known anomaly	S-300
94292	941106	1	AINSTAT failed config monitor check	Previously reported	S-301
94293	941109	1	AINSTAT failed config monitor check	Previously reported	S-302
94294	941118		Error in close data set smd in sig events	Expt'd fm prblms in last pass; worked around; all activities completed successfully	S-303
94295	941122	8	Two mnemonics flagged in LOS config monitor		S-304
94296	941211	5	Internal error	Caused by internal S/W bus error	S-305

## Appendix IV. Spacecraft Lifetime Data

NOTE: In the following table, the term “useful life” refers to the time during which the major mission objectives were met. Active life is the total lifetime during which the satellite remained in service. Design, useful and active lives are given in years. A blank space means the information was not available. Data are through December 1994.

Spacecraft / Class	Launch Date	Design Life	Useful Life	Active Life	Remarks
TIROS	04/01/60	0.25	0.24	0.24	TV system useful for 77 days
Explorer VIII (S-30)	11/03/60	0.25	0.15	0.15	Last transmission 12/28/60
TIROS II	11/23/60		0.63	1.03	TV data useful to 7/12/61
Explorer XI (S-15)	04/27/61		0.61	0.61	Last transmission 12/7/61
TIROS III	07/12/61	0.25	0.40	0.63	TV data useful to 12/4/61. Lost tape recorders.
Explorer XII (S-3)	08/15/61	1.00	0.31	0.31	Transmission ceased abruptly
TIROS IV	02/08/62	0.25	0.36	0.44	TV useful to 6/9/62. Lost tape recorders.
OSO-I	03/07/62	0.50	1.40	1.40	Lost tape recorder @ 2 mos. Starfish incident degraded power system.
Ariel-I (S-51)	04/26/62	1.00	0.88	0.88	Degraded by Starfish incident of 7/9/62
TIROS-V	06/19/62	0.50	0.88	0.88	TV useful to 5/4/63. Camera filaments failed.
TIROS-VI	09/18/62	0.50	1.06	1.06	TV useful to 10/11/63. Filaments and focus out.
Explorer XIV (S-3a)	10/02/62		0.85	1.20	Last transmission 2/17/64
Explorer XV (S-3b)	10/27/62	0.17	0.26	0.55	Despin system failed. Last transmission 5/19/63
Relay I	12/13/62	2.00	2.53	2.53	
Syncom I	02/14/63	2.00	0	0	Lost power. Mission failure.
Explorer XVII (S-6)	04/03/63	0.25	0.27	0.27	Batteries degraded. No solar array.
TIROS-VII	06/19/63	0.5	4.33	4.96	Deactivated. Camera focus out 12/65
Syncom-II	07/26/63	2.0			
IMP-A	11/26/63	1.0	0.82		
TIROS-VIII	12/21/63	0.5	3.53	3.53	Deactivated
Relay-II	01/21/64	1.0	1.68	3.50	
Ariel-II (S-52)	03/27/64	1.0	0.53		Had spin rate and attitude control problems
Syncom-III	08/19/64	3.0			
Explorer-XX (S-48)	08/25/64		1.60	1.60	Lives based on last transmission of 3/30/66
Nimbus-I	08/28/64	0.5	0.07	0.07	Solar array drive failed
OGO-1(A)	09/04/64	1.0	5.23	5.23	Mission failure; 3 axis stabilization not achieved.
IMP-B	10/03/64	1.0	0.50	1.25	Reentered. Placed in wrong orbit.
Explorer-XXVI(S-3c)	12/21/64	1.0	2.10	2.10	Last transmission 1/21/67
TIROS-IX	01/22/65	0.5	2.73	3.40	Deactivated. Camera contrast out 10/66.
OSO-II	02/03/65	0.5	0.75	0.75	Used up control gas
IMP-1 (C)	05/29/65	1.0	1.92	1.92	Reentered
TIROS-X	07/02/65	1.0	1.16	2.00	Deactivated
OGO-2 (C)	10/14/65	1.0	3.48		Mission failure; horizon scanners did not maintain earth lock.
ESSA-I	02/03/66	1.0	2.36	2.36	Deactivated
ESSA-II	02/28/66	1.0	4.64	4.64	Deactivated
OAQ-I	04/08/66	1.0	0	0	Mission failure: lost power.
Nimbus-II	05/16/66	0.5	2.67	2.67	ACS scanner failed
AE-B	05/25/66	0.5	0.82		Higher than planned orbit. Two sensors did not work.
OGO-3 (B)	06/06/66	1.0	2.04	3.50	Boom oscillation problem
AIMP-2 (D)	07/01/66	0.5	4.92		Failed to achieve lunar orbit
ESSA-III	10/02/66	1.0	2.02	2.02	Deactivated. Cameras failed
ATS-I	12/06/66	3.0		ACTIVE	Gas expended. Subsequent limited service.
ESSA-IV	01/26/67	1.0	0.41	1.27	Deactivated: one camera failed, one degraded.

# Appendix IV. Spacecraft Lifetime Data

Spacecraft / Class	Launch Date	Design Life	Useful Life	Active Life	Remarks
OSO-III	03/08/67	0.5	3.00	3.00	Tape recorder at 18 months. ACS controlled manually.
ESSA-V	04/20/67	1.0	2.83	2.83	Deactivated. IR failed, cameras gradually degraded.
IMP-3 (F)	05/24/67	1.0	1.95	1.95	Reentered
AIMP-4 (E)	07/19/67		3.50	3.50	Lunar orbit. Subsequent period of intermittent operation.
OGO-4 (D)	07/28/67	1.0	2.24	2.75	Thermal bending of antenna caused stabilization control problem
OSO-IV	10/18/67	0.5	0.90		Tape recorder failure at 6 months
ATS-III	11/05/67	3.0		ACTIVE	Instruments no longer in use
ESSA-VI	11/10/67	1.0	2.09	2.09	Deactivated. Cameras degraded.
OGO-5 (E)	03/04/68	1.0	3.60	3.60	Deactivated. Data glut.
RAE-A	07/04/68	1.0	4.50	4.50	Deactivated. Data quality had become marginal.
ESSA-VII	08/16/68	1.0	0.92	1.56	Deactivated. Early camera and tape recorder failures.
OAO-II	12/07/68	1.0	4.20	4.20	Primary instrument (WEP) failed.
ESSA-VIII	12/15/68	1.0	4.95	6.75	Deactivated: camera problems.
OSO-V	01/22/69	0.5	3.90	3.90	
ESSA-IX	02/26/69		4.10	4.10	Deactivated. Standby after 4/71.
Nimbus-3	04/19/69	0.5	2.67		ACS scanner failed 1/72.
OGO-6 (F)	06/05/69	1.0	2.06	2.25	Deactivated. Data glut.
IMP-5 (G)	06/21/69		3.51	3.51	Reentered.
OSO-VI	08/06/69	0.5	3.30	3.30	
ATS-V	08/12/69	3.0	14.84	14.84	Mission officially unsuccessful. Stabilization not achieved. Deorbited 3/20/84.
TIROS-M	01/23/70	1.0	1.40	1.40	Momentum wheel assembly failed.
Nimbus-4	04/08/70	1.0	10.00	10.00	Deactivated
NOAA-1 (ITOS-A)	12/11/70	1.0	0.56	0.75	Deactivated: momentum wheel assembly problems.
SAS-A	12/12/70	0.5	4.00	4.00	Transmitter failure terminated mission.
IMP-6 (I)	03/13/71	1.0	3.56	3.56	Reentered.
OSO-VII	09/29/71	0.5	3.17	3.17	Reentered due to bad orbit.
SSS-A	11/15/71	1.0	2.87	2.87	Deactivated: battery unusable, as expected, after one year.
Landsat-1 (ERTS-A)	07/23/72	1.0	5.58	5.58	Deactivated. Funding withdrawn.
OAO-C	08/21/72	1.0	8.50	8.50	Deactivated. Funding withdrawn.
IMP-7 (H)	09/22/72	2.0	6.10	6.10	Power system failed.
NOAA-2 (ITOS-D)	10/15/72	1.0	2.25	2.40	Standby after 3/74. Some experiments failed.
SAS-B	11/16/72	0.5	0.54	0.54	Experiment low voltage power supply failed.
Nimbus-5	12/12/72	1.0	10.30	10.30	Second HDRSS failed 7/27/82. Deactivated 3/31/83.
RAE-B	06/10/73	1.0	3.75	3.75	Deactivated. Mission objectives achieved.
IMP-8 (J)	10/25/73	2.0	ACTIVE	ACTIVE	All instruments operating.
NOAA-3 (ITOS-F)	11/06/73	1.0	2.84	2.84	Deactivated. Radiometer, VTPR, VHRR out.
AE-C	12/16/73	1.0	5.00	5.00	Reentered.
SMS-1	05/17/74	2.0	1.60	6.70	Standby after 1/76. Deactivated 1/31/81.
AT-6 (F)	05/30/74	5.0	5.17	5.17	Deactivated.
NOAA-4 (ITOS-G)	11/15/74	1.0	4.00	4.00	Deactivated. Radiometer, VHRRs out.
Landsat-2	01/22/75	1.0	8.51	8.51	Yaw flywheel stopped 11/79, recovered 5/80.

## Appendix IV. Spacecraft Lifetime Data

Spacecraft / Class	Launch Date	Design Life	Useful Life	Active Life	Remarks
					Deactivated 7/27/83.
SMS-2 (B)	02/06/75	2.0	6.50	7.50	Second encoder failed 8/5/81.
SAS-C	05/07/75	1.0	4.92	4.92	Reentered.
Nimbus-6 (F)	06/12/75	1.0	7.18	8.28	Yaw flywheel failed 8/14/82.
OSO-8 (I)	06/21/75	1.0	3.40	3.40	Funding withdrawn.
AE-D	10/06/75	1.0	0.42	0.42	Shorted diode in power supply electronics.
GOES-1 (A)	10/16/75	3.0	9.30	9.40	VISSR failed 2/85.
AE-E	11/20/75	1.0	5.56	5.56	Reentered 6/10/81.
NOAA-5 (ITOS-H)	07/29/75	1.0	2.96	2.96	Failed 7/79.
GOES-2 (B)	06/16/77	3.0	1.55	ACTIVE	VISSR failed 1/79, batteries degraded; made semi-operational as West DCS S/C.
ISEE-1 (A)	10/22/77	2.0	9.93	9.93	Spacecraft reentered 9/26/87.
IUE	01/26/78	3.0	ACTIVE	ACTIVE	Fully operational; some problems with computer "halts".
Landsat-3 (C)	03/05/78	3.0	5.07	5.51	Problems with MSS instrument.
AEM-A (HCMM)	04/26/78	1.0	2.40	2.40	Deactivated. Battery degraded 9/14/80.
GOES-3 (C)	06/16/78	3.0	2.21	ACTIVE	VISSR degraded 9/80, failed 5/6/81. To standby 4/28/87. Sdbdy S-band commun. only (4/90).
ISEE-3 (C) [ICE]	08/12/78	2.0	ACTIVE	ACTIVE	Some instrument losses. JPL funding science (10/92).
TIROS-N	10/13/78	2.0	2.38	2.38	ACS failed 2/27/81.
Nimbus-7 (G)	10/24/78	1.0	15.18	15.46	Ceased its science mission 12/93; spacecraft degraded. Lost S/C acquisition 4/94.
AEM-B (SAGE)	02/18/79	1.0	2.75	2.75	Battery degraded. Failed 11/18/81.
NOAA-6 (A)	06/27/79	2.0	7.39	7.75	Spacecraft turned off 3/31/87.
Magsat	10/30/79	0.4	0.61	0.61	Reentered as planned 6/11/80.
SMM <sup>+</sup>	02/14/80	2.0	0.83/ 5.62	9.78	Lost fine pointing control 12/12/80; repaired. Mission terminated 11/24/89; reentered 12/89.
GOES-4 (D)	09/09/80	7.0	2.21	6.66	VAS failed 11/25/82.
GOES-5 (E)	05/22/81	7.0	3.19	9.20	VAS failed 7/30/84. Loss of station keeping 12/89. Deactivated 7/18/90 (out of station-keeping fuel).
NOAA-7 (C)	06/23/81	2.0	3.62	4.92	Failed HIRS, degraded SSU, disabled power system.
DE-1 (A)	08/03/81	1.0	9.57	9.57	Mission terminated (can't command S/C) 2/28/91.
DE-2 (B)	08/03/81	1.0	1.54	1.54	Reentered as expected 2/19/83.
OSS-1	03/22/82				Shuttle attached payload mission.
Landsat-4 (D)	07/16/82	3.0			No longer monitored nor reported herein.
NOAA-8 (E)	03/28/83	2.0	1.25	1.25	Failed 7/1/84. Recovered 5/85. Failed again 1/86.
TDRS-1 (A)	04/04/83	*10.0	ACTIVE	ACTIVE	Some loss of capability. Activated in 1993 for GRO data via Australia.
GOES-6 (F)	04/28/83	7.0	5.73	ACTIVE	VAS failed 1/21/89. Loss of station keeping 5/92 W. DCS ops term. 9/92; providing SEM data.
Landsat-5 (D)	03/01/84	3.0			No longer monitored nor reported herein.
AMPTE/CCE	08/16/84	1.0	4.92	4.92	Some solar array degradation. Mission terminated 7/14/89.

<sup>+</sup> - Repaired by STS 41-C crew on April 12, 1984.

\* - Complex warranty provisions call for 10 year service from TDRSS system

## Appendix IV. Spacecraft Lifetime Data

Spacecraft / Class	Launch Date	Design Life	Useful Life	Active Life	Remarks
ERBS	10/05/84	2.0	ACTIVE	ACTIVE	All gyros except IRU-1/Z failed. ERBE-S failed 2/90. Batt. #1 disconnected 8/92 ( 2 shorted cells). Batt. #2 lost 2 cells 6/7/93, ERBE-NS is temporarily off.
NOAA-9 (F)	12/12/84	2.0	3.92	ACTIVE	MSU & ERBE-S failure. Into standby 11/8/88.
SPARTAN-1	06/20/84				STS attached payload mission.
SPOC/HITCHHIKER	01/12/86				STS attached payload mission.
NOAA-10 (G) / B	09/17/86	2.0	ACTIVE	ACTIVE	Array shunts degraded. ERBE-S & SARP failed. Roll gyro failed, AVHRR degraded 11/92. In standby ops.
GOES-7 (H) / A	02/26/87	7.0	ACTIVE	ACTIVE	
NOAA-11 (H) / B	09/24/88	2.0	ACTIVE	ACTIVE	Y-Gyro & DTR-5 A&B failed in late 89. DTR-1B failed 2/92.
TDRS-3 (C) / B	09/29/88	*10.0	ACTIVE	ACTIVE	Standby status 8/91.
TDRS-4 (D) / B	03/13/89	*10.0	ACTIVE	ACTIVE	
COBE	11/18/89	0.83	4.10	4.10	Gyro-B failed 11/89, ESA-A failed 4/91, BX gyro failed 9/91 & gyro A&C failed 1993. Science mission ended 12/23/93.
PEGSAT	04/05/90	0.25	0.75	0.75	PEGASUS launched. Limited life mission.
HST / B	04/24/90	15.0	ACTIVE	ACTIVE	Spherical aberration in primary mirror. Gyros 4&5 failed. Gyros 1&6 failed 10/11/92. 1st servicing mission 12/93
SSBUV	10/06/90				STS attached payload mission.
BBXRT	12/02/90				STS attached payload mission.
GRO	04/07/91	2.25	ACTIVE	ACTIVE	Propulsion system damaged/degraded. DTR ops stopped 4/92 due to high error rate. MPS bad 7/92. Orbit reboosted to 450 km late 1993.
NOAA-12 (D) / B	05/14/91	2.0	ACTIVE	ACTIVE	
TDRS-5 (E) / A	08/02/91	*10.0	ACTIVE	ACTIVE	
UARS / S/C B Instr.'s C	09/15/91	3.0	ACTIVE	ACTIVE	ISAMS instrument failed 7/92. Cryogenics depleted in CLAES instrument 5/93; its science ended. Eight instruments still active.
SSBUV	03/24/92				STS attached payload mission.
EUVE / B	06/07/92	1.13	ACTIVE	ACTIVE	
SAMPEX(SMEX-1)/ C	07/03/92	3.0	ACTIVE	ACTIVE	
TDRS-6 (F) / A	01/13/93	*10.0	ACTIVE	ACTIVE	Put in on-orbit storage 6/93.
NOAA-13 (I) / B	08/09/93	2.0	0.03	0.03	Anomaly in power subsystem caused loss of spacecraft 8/21/93.
HST [SM-01]	12/02/93				HST servicing mission: COSTAR, WF/PC II, 2RSUs, SAs, etc. installed. See HST entry above.
GOES-8 (I) / A	04/13/94	5.0	ACTIVE	ACTIVE	
SPARTAN 201-02/ D	09/94	40 Hrs.			STS attached payload mission. WLC instr. failed.
Wind (GGS / B	11/01/94	3.0	ACTIVE	ACTIVE	
NOAA-14 (J) / B	12/30/94	2.0	ACTIVE	ACTIVE	

\* - Complex warranty provisions call for 10 year service from TDRSS system